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Problems Evolve Melting Changes

A Fragment of History from a Prominent Foundry in Detroit—How Progressive Management Led to Successive Improvements—Features of Electric Furnace Practice

SOME years ago when the United States Steel Corp. announced its plans for building a complete steel works, with a city to house the workmen, on the sand dunes of southern Lake Michigan, the whole country was interested. As the work progressed the newspapers featured it in their Sunday editions and people who knew nothing about a modern steel plant talked about the most wonderful achievement. It was a wonderful achievement, this marshalling together of the advancement of the past and utilizing it in building such a complete metallurgical unit. It required imagination, ability and courage to conceive this huge undertaking. This could easily be realized by every one who read about it. But there have been many projects in the metallurgical field which took just as much courage, imagination and ability in the individuals behind them as did the building of this great steel works. The struggles of the man who starts with a limited capital in a small way and gradually expands as he makes profits through handling his small unit to the best advantage, would prove as interesting as many accomplishments on a larger scale, if they could be surrounded with the same dramatic properties. A business which was started in a small way and gradually grew, due to the ability of its management, making one improvement after another, adding one building after another to the ones already up, is the Michigan Steel Casting Co., Detroit. In 1907 this concern started making crucible steel castings. At first a 12-pot furnace was installed. This was added to until there were 24 crucible holes in operation. Then the demand again became too heavy for the furnace capacity and it was decided to install a converter instead of putting in more crucible furnaces. As the workmen became used to handling the metal from the converter, the crucible furnaces were dismantled, a few at a time, and other converters added, un-

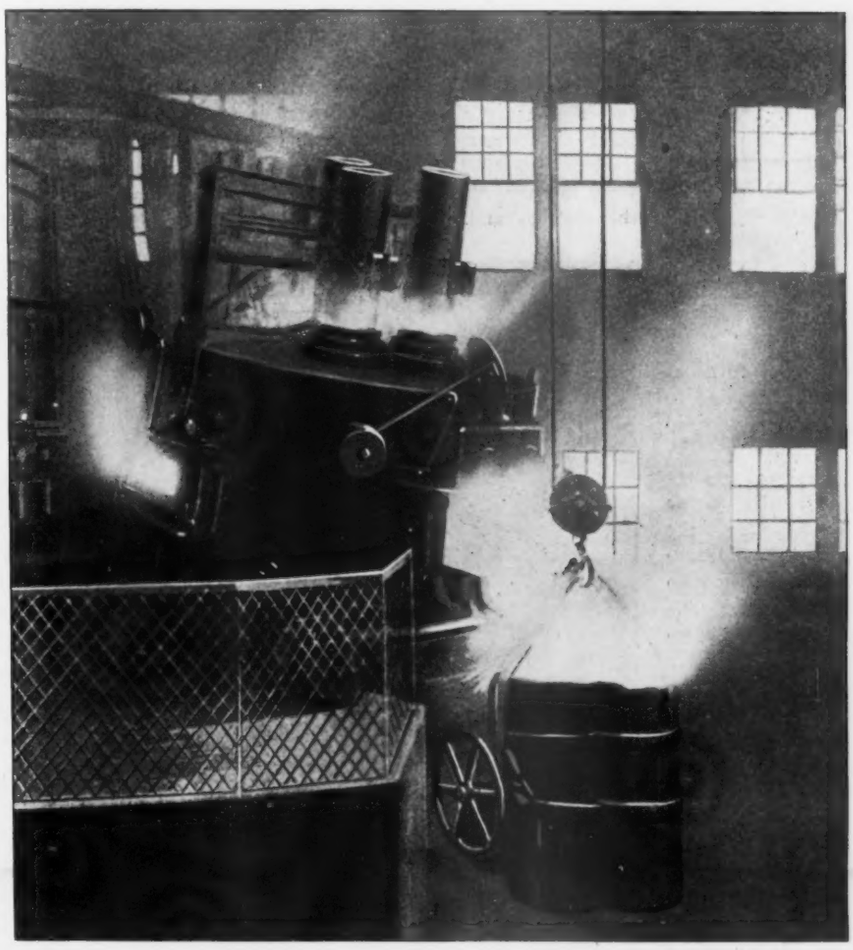

FIG. 1—ONE OF THE 3-TON HEROULT FURNACES, SHOWING THE POURING LADLE

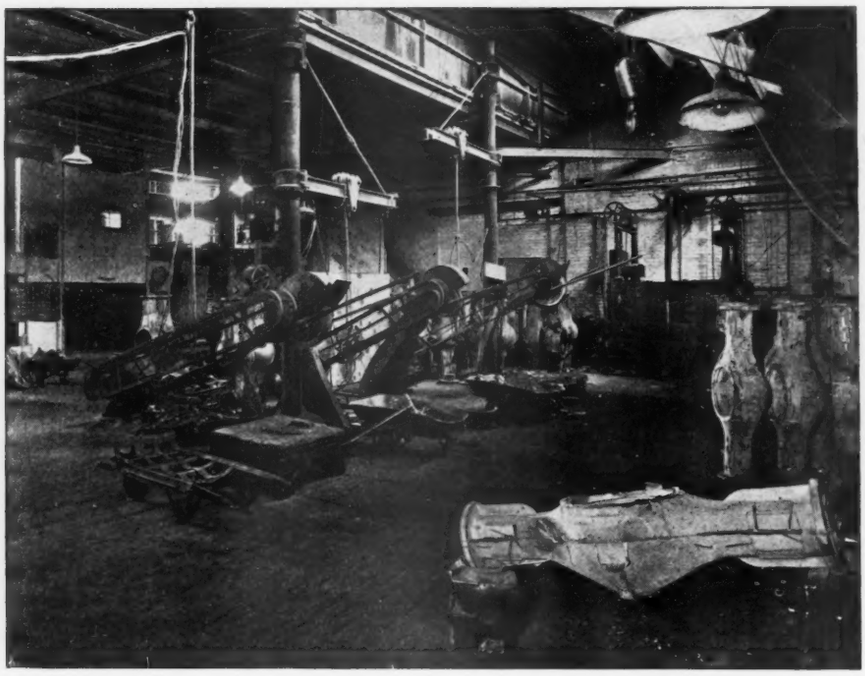

FIG. 2—A PORTION OF THE CLEANING ROOM SHOWING ARRANGEMENT OF THE GRINDING WHEELS

til finally there were no more crucibles in operation and the company had one 2-ton and two 1-ton converters. This change from crucible to converter, being gradual, did not cause a great deal of trouble, although some difficulty was experienced until the men became familiar with operating the converters and handling the metal in 1-ton lots.

After the converters had been in operation for a few years, it became apparent to the officials of the company that owing to the somewhat different class of orders coming in and to stricter specifications and closer inspection, it would be advisable to have a means of making a higher grade of metal than they could produce in the converter. With this end in view a study of the different kinds of electric steel furnaces was made and it was finally decided to install a 6-ton heroult furnace and do away entirely with the converters.

This involved quite a radical change and a number of difficulties arose promptly, especially in handling the metal. Pouring six tons of metal into molds for light castings was found to be entirely different from handling one or two tons at a time. Practically no trouble was experienced in producing a metal which met the requirements of the specifications with respect to physical properties, but for more than six months unusual trouble was encountered due to lack of sufficient experience in handling the metal in the foundry. Later more furnace capacity was required and a 3-ton heroult furnace was installed. This proved satisfactory so when it again become necessary to increase the furnace capacity another furnace of the same kind and capacity was purchased. When the electric furnaces were installed they were lined with basic bottoms but later the linings were changed and the furnaces are now operated with acid bottoms.

From the foregoing it will be seen that the men at the head of the Michigan Steel Casting Co. had courage to make changes which their judgment of conditions showed were desirable. And the fact that every change has proved beneficial demonstrates the correctness of their foresight. It is worth while, therefore, to study the reasons which induced the changes and the advantages gained.

The first change, that from the crucible furnaces to the converters, was made primarily on account of lack of space, since for the same output considerably less space is required for converters than for crucibles. Another reason was that at the time a steel which would fill all the requirements could be made cheaper in a converter.

Later when more difficult castings came into the foundry and more rigid inspection was instituted, the company decided to install a 6-ton heroult electric furnace which it was thought would give metal specially adapted to its needs. This has since proved true and it has been found that in several cases castings which formerly were difficult to make are now produced with little trouble using electric-furnace steel and the same pattern gated as before. In another instance a casting which nearly always required welding now comes out satisfactorily without welding when made of electric-furnace steel. This is partly due to the fact that converter steel is highly oxidized in blowing. After the blow the deoxidizing alloys are added in the converter and the metal then allowed to stand only a few minutes before pouring. With the electric furnace the steel is kept under a deoxidizing slag for 45 minutes before pouring. This gives opportunity for the occluded gases to escape and thoroughly deoxidizes the metal.

The steel made in the electric furnace is dense and homogeneous. Two ways in which the physical characteristics are shown to be good are in the high ratio of elastic limit to ultimate strength and in great endurance under the vibration or fatigue tests which have been made.

FIG. 3—ANOTHER SECTION OF THE CLEANING ROOM SHOWING HOLLOW TRUCK WHEELS CAST WITH A SINGLE CORE

In the basic-lined electric furnace, the sulphur and phosphorus can both be materially reduced, and in the acid-lined furnace the percentage of these elements is not materially changed. But the metal on being melted in the cupola for the converter takes up sulphur from the coke. Beside this, while not losing or gaining any sulphur or phosphorus in the converter, approximately 17 per cent of the metal is lost by oxidation thus raising the proportion of the other elements to the steel. The question of costs also entered into consideration, for at the time the change was made steel could be made in the electric furnace at less cost than in the converter. This difference was considerably accentuated during the war when there was a plethora of basic steel turnings and the price of basic pig iron increased. Another fact to be taken account of is that there is a melting loss of only 4 per cent in the electric process.

The next change made was from the 6-ton to the 3-ton heroult furnace. This was done so that there would be less metal to pour at one time, as it is highly important that the metal be gotten into the molds as soon as possible after being tapped. The importance of this is shown by the fact that a report is made on every heat showing the length of time taken to tap the furnace and to pour all the steel into the molds. In case of dispute between the foundry and the furnaceman on account of the steel being too cold to run freely, the pouring time report serves as the umpire. The average tapping time is from 5 to 10 minutes, while frequently a 3-ton ladle is poured in 12 minutes and again 30 minutes are required.

After a thorough trial of both sized furnaces the company has concluded that the 3-ton furnace is the more economical. The average power consumption per ton of steel melted is 625 kilowatt-hours for the 3-ton furnace and 650 for the 6-ton furnace. Of course better records than this have been made when everything went like clockwork—no broken electrodes, furnace working at its best and the foundry taking heats as fast as made. Under such conditions the best record for a week's run, which was made with the 3-ton furnace, was 518 kilowatt-hours per ton of steel made.

The ratio of output on these two furnaces is 3 to 2 instead of 2 to 1 as might be expected. This is due to the proportionately shorter time required to melt a heat in the 3-ton furnace. The best record made in this respect was the melting of 54 consecutive heats in 144 hours, which is at the rate of one heat in 2 hours and 40 minutes. A little hotter metal is also obtained from the 3-ton furnace.

FIG. 5—WOMEN'S CORE ROOM. NOTE THE RACKS USED FOR HANDLING THE CORES

FIG. 4—NARROW GANGWAY LEADING BETWEEN THE ELECTRIC FURNACES TO THE MOLDING FLOORS

When the electric furnaces had been working for about six months it became impossible to secure refractories for basic lining and it was necessary to line the furnaces with acid materials. Although this change was made as a result of unavoidable conditions it proved very satisfactory and now although basic refractories are again available, the acid linings are being continued. Another indication of the advantage of acid bottoms is that now when it is becoming difficult to get enough low-priced basic-steel scrap, instead of going back to basic linings on all furnaces the company is contemplating lining one of the furnaces basic and using it for melting the charge and reducing the sulphur and phosphorus, then finishing in one of the other furnaces under an acid slag.

In comparing the two linings it is found in the first place that the acid refractories are the less expensive. But the more important consideration is that the acid roof and lining last 8 to 12 times as long as the basic roof and lining. The furnaces are operated at such a high heat in order to get the metal hot enough to run thin section castings that a basic roof or lining will not last two weeks. This means either the furnace must be relined every week or that there will be a shut-down during the next week. Therefore, with the basic

lining the Sunday closing period was used each week to reline the furnaces. In contrast to this, the acid furnaces stand up from 8 to 12 weeks without relining. The difference may be accounted for by the fact that the basic slag gets quite thin toward the end of the run and reflects the heat on the roof and lining to a much greater extent than the heavier acid slag. This question of linings is not entirely one of direct expense but is also a matter of having the furnace available on all working days.

The thin basic slag has also shown itself to be a disadvantage when the steel is poured from the furnace into the ladle. The stream of metal and slag plunges into the ladle and the two are churned up together. The thin slag is thus emulsified with the steel. This is shown by the finding of slag inclusions in the center of castings made from basic metal, which would indicate that the slag had not freed itself from the steel. The acid slag is more viscous and no such conditions have been found with acid steel castings.

Again the basic slag does not protect the metal in the ladle as well as the acid slag, which forms a crust over top of the ladle, thus preventing the cool air from getting to the metal and chilling it. The heat insulating properties of the acid slag are so good that the last steel poured from a 3-ton ladle is nearly as hot as the first.

It will be well to review the furnace practice which has resulted from the experience gained from these different changes. The make-up of the charge is largely dependent upon conditions of the steel market. During the war when it was easy to procure low phosphorus turnings the charge was made up of 100 per cent turnings and the gates and risers were sold at a higher price than was paid for the turnings. At present the charge consists of 40 per cent returned gates and risers, 30 per cent heavy, short turnings, and 30 per cent plate scrap. Of all the scrap used the turnings are the easiest to handle, because when short and heavy they are readily shoveled into the furnace.

Carbon electrodes are used and the records show that when the electrodes are normal there is a loss of 34 pounds of electrode per ton of steel. The company has no objection to graphite electrods and uses carbon ones because they were more readily obtained.

When the metal is melted it is sometimes found advisable to pull the slag and make a new one instead of trying to deoxidize it in the furnace. If it is decided to deoxidize the slag, powdered coal is thrown on it. This reduces some of the iron and manganese in the slag, but the action may not be carried to the complete reduction of all the iron and manganese, as after the silica in the slag is increased to 55 or 60 per cent, further reduction of the other metals also reduces silica and throws silicon back into the steel. With 55 per cent silica, the slag becomes too viscous and a small amount of lime is added to give a little more fluidity . The final slag contains 50 to 60 per cent of silica and the remainder is iron and manganese oxides with a little lime, never more than 8 per cent.

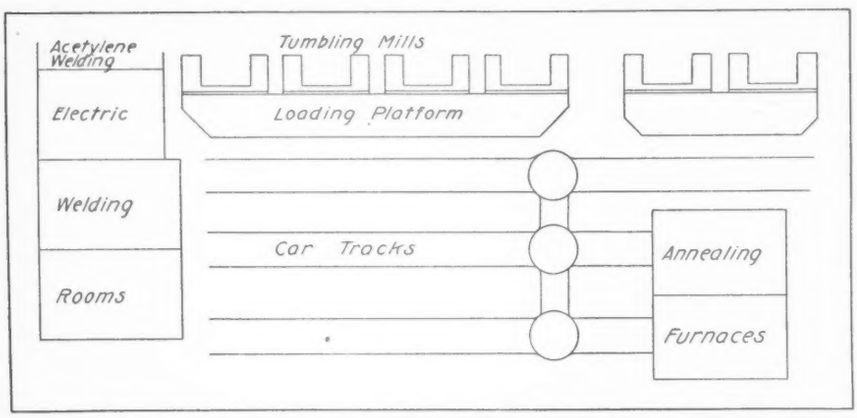

FIG. 6—PLAN OF THE ANNEALING DEPARTMENT SHOWING THE LAYOUT OF THE TRANSFER TRACKS

The head melter is a man who has had a technical education, and he is given free leeway in running the furnaces. For all regular heats he determines the carbon in the metal by the fracture test, while only for high carbon heats is a test sent to the laboratory. Only rarely is the carbon too high when the steel is melted. In such cases it must be reduced by the addition of mill scale or hemitite ore. Should the carbon be too low it is raised by the addition of either pig iron or spiegel. The question as to whether the steel is hot enough to pour or not is also left to the melter who determines it by the judgment of his eye as a spoonful is poured into a test mold.

The finished metal is poured into a 3-ton ladle provided with a teapot spout. This ladle is lined with tamped-in ganister, and such a lining will last 15 heats. From the crane ladle the steel is transferred to bull ladles for casting into molds. This can be done because the castings made range in weight from one ounce to a maximum of 300 pounds. A very little aluminum or carbon-free titanium is added to the bull ladles, approximately ½ pound to a ton of metal. This is called an insurance policy because although the shop may run a long while without these deoxidizers, occasionally there would be trouble due to the steel becoming oxidized in the hand shanks or in the molds.

The general run of castings are made from steel within the following range of composition: Carbon, 0.25 to 0.30 per cent; manganese, 0.65 to 0.75 per cent; sulphur and phosphorus less than 0.05 per cent; silicon, 0.30 per cent. The sulphur will usually run 0.045 per cent and the phosphorus 0.040 per cent. Besides this grade of steel, steels with different amounts of carbon as well as numerous alloy steels are made.

The castings are either annealed or given some kind of a double heat treatment. Those of less complicated design can be quenched in oil or water and then drawn at the proper temperature to give them the ductility required. This treatment is similar to that given forged and rolled steel and adds materially to both the strength and ductility of the metal. Another treatment that the Michigan Steel Casting Co. frequently gives its castings is to heat them, quench in air and again heat. In this treatment the castings are heated three hours at 1550 degrees Fahr. then pulled out into the air and allowed to cool. After this they are heated to 1100 degrees Fahr. and held at this temperature for two hours. Such a treatment increases the elastic limit 10,000 to 20,000 pounds per square inch and the tensile strength of the steel 5000 to 8000 pounds per square inch, but does not materially change the elongation or reduction of area. The elastic limit and tensile strength can be still further increased at the expense of ductility by drawing at a lower temperature, or the converse results may be obtained by drawing at a higher temperature.

In order to heat-treat castings two departments have been established. In one all castings which are quenched in water or oil are treated; and the other is used for annealing and air quenching. The layout of the latter departments is shown in Fig. 6. Castings are sand blasted and, when necessary, welded before they are heat treated. After the treatment they are dumped on the loading platform alongside of the tumbling barrels, and all of them are put through the tumblers to clean off the oxidized scale which is formed in the furnace.

The furnaces are of the car-type as seen in Fig. 8 and are equipped with indicating pyrometers made by the Hos-

kins Mfg. Co., Detroit. They are fired with oil, using burners made by the Mahr Mfg. Co., Minneapolis.

As has been previously noted the Michigan Steel Casting Co. started from small beginnings and added to its plant as business increased. This presented some difficulties which would not have been encountered had the plant been designed for future expansion which has proved greater than was ever contemplated. The way this has been finally worked out teaches some lessons.

The furnaces are located at one end of a bay which cuts through the shop in the middle. This bay is served by a 5-ton crane made by the Toledo Bridge & Crane Co., Toledo, O., and a 10-ton crane built by the Euclid Crane & Hoist Co., Euclid, O. These cranes also run out of the building over the railroad yard tracks. Thus they are used to unload sand and scrap which are stored in that portion of the bay not used by the furnaces. Two of the furnaces are located on one side of a narrow gangway and the other furnace stands on the opposite side. The crane overhead transfers the ladles to 5-ton cranes in the molding bays which run at right angles to both sides of the furnace section. Paralleling the main molding floors on both sides are molding sections served by 1-ton cranes, with one crane to 60 feet of runway.

Molding machines of various types are used according to the class of work turned out. For the lighter castings three hand-squeezer machines built by the Tabor Mfg. Co., Philadelphia, and 12 jar-ram rollover machines made by the Buch Foundry Equipment Co., York, Pa., are used. At one end of a molding bay covered by a 5-ton crane, two jar-ram rollover machines made by the Herman Pneumatic Machine Co., Pittsburgh, are set up under sand bins which deliver the sand to them by gravity. These machines are used for making the heavier molds.

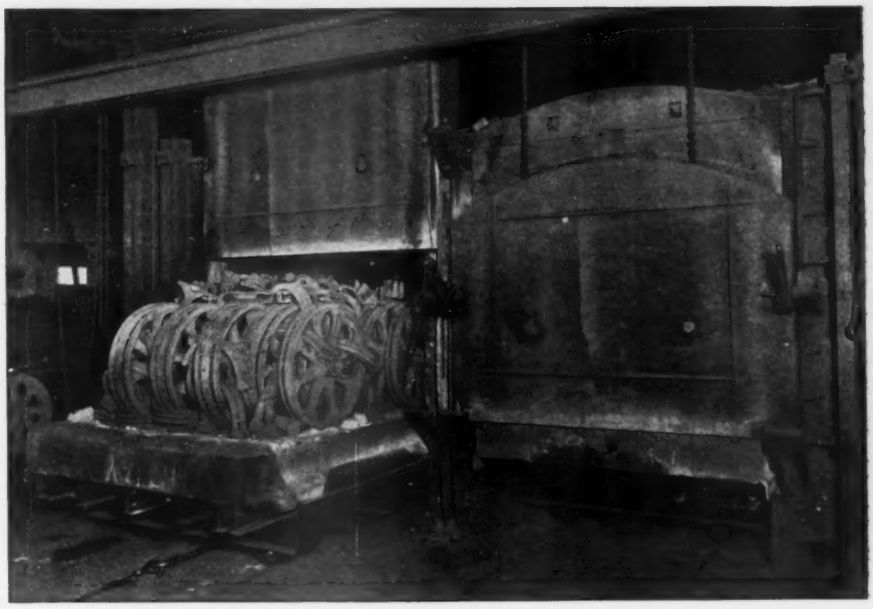

FIG. 8—ONE OF THE ANNEALING OVENS CLOSED AND A CHARGE OF CASTINGS ENTERING THE OTHER

As is quite usual the cranes are used to a great extent to move materials about in the foundry. While most of the material is handled in this way a considerable amount also is handled on low, 3-wheeled trucks pulled either by laborers or by storage battery cars made by the Elwell Parker Electric Co., New York. When hauled by the battery cars several trucks are frequently connected into a train.

The company has its own plant for generating oxygen used for welding and for cutting off gates and risers. At the same time the oxygen is generated, twice the volume of hydrogen is produced. At present this is used only for cutting and the remainder is allowed to escape into the atmosphere, but preparations are being made to try to replace the acetylene used in welding with hydrogen.

Recently a new 3-story building was built for the core department. The first floor is used to store the sand and coke needed in the core department. The firing boxes for the core ovens are also on this floor. On the second floor is the men's core room and the third floor is devoted entirely to a woman's core room. All cores are handled on racks as shown in Fig. 5. These racks are placed in the ovens by the use of a lift-truck made by the Steubing Truck Co., Cincinnati. They are taken down to the foundry floor on an elevator and carried around the foundry by the cranes.

The Michigan Steel Casting Co. aims to be liberal in its treatment of its employes. The foremen and heads of departments receive bonuses, while the workmen are paid according to piece rate scales with time and a half for overtime. A cafeteria restaurant is operated for the benefit of the employes. It is open to the shop men from 11:30 until noon and afterwards to the office people. Every employe is insured by the company. Dressing and rest rooms are provided for both men and women. Besides there is a central locker room, a first aid room, and shower baths.

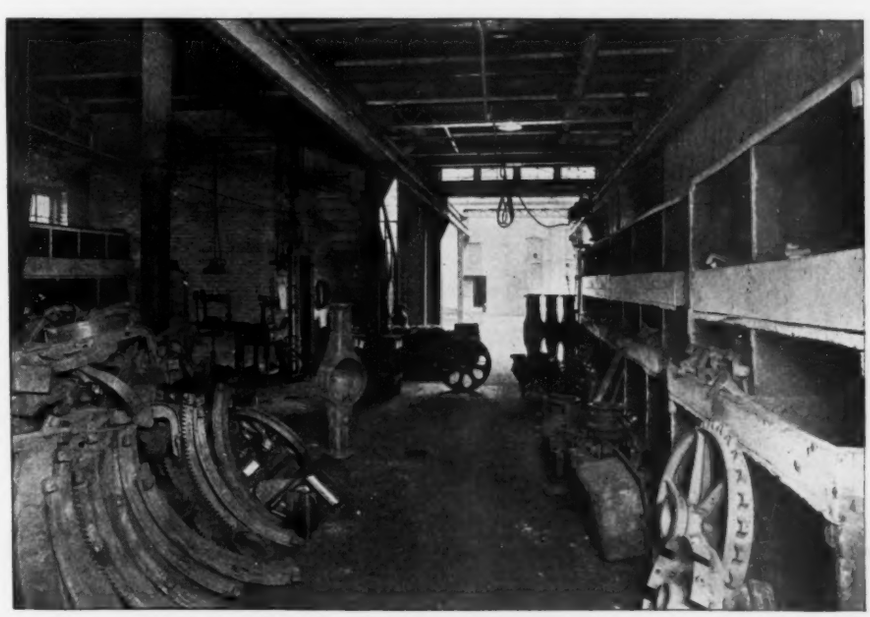

FIG. 7—A VIEW OF THE SHIPPING ROOM GIVES AN IDEA OF THE DIFFERENT KINDS OF CASTINGS MADE

The Leeds and Northrup Co., Philadelphia, manufacturers of the potentiometer system of pyrometry and other electrical measuring instruments, opened a branch office recently at 1304 Monadnock block, Chicago. Henry Brewer is in charge.

A. S. T. M. Meets at Atlantic City

President Advocates Adoption of Metric System—Sulphur Limits Lowered on Some Steel Specifications But Unchanged for Steel Castings—Malleable Specifications Approved Require Higher Tensile Strength and Elongation

ALONG with specifications for steel, nonferrous metals and other materials discussed at the annual meeting of the American Society for Testing Materials, held in Atlantic City, June 24-27, the society's specifications for steel and malleable castings were considered. The tentative standard specifications for malleable castings were recommended for adoption as standard and to supercede the present standard specifications of the society for malleable-iron castings.

On Tuesday, June 25, the retiring president, Guilliam H. Clamer, second vice president and secretary of the Ajax Metal Co., Philadelphia, addressed the meeting on standardization. In his address Mr. Clamer made a plea for the metric system of weights and measures and said: "To change from one system of weights and measures to another is no easy matter and is exceedingly costly. The advantages to be gained, however, are so far reaching that the loss occasioned would be soon wiped out."

Following the president's address a memorial service was held for Edgar Marburg, former secretary-treasurer of the society. For the first time in the history of the society honorary memberships were bestowed, the members thus distinguished being Henry M. Howe, Bedford Hills, N. Y.; Robert W. Hunt, Chicago, and Mansfield Merriman, New York.

The scope of the work of the society is shown by the fact that before the convention it had 128 standard specifications for materials and 49 tentative specifications.

The tentative specifications on cast steel anchor chains were not recommended for adoption as standard, but will be retained as tentative without revision. The committee is giving further consideration to some details of the shock test and whether chemical requirements, particularly as to sulphur and phosphorus, shall be put in.

At the time of the annual meeting of the society in June, 1918, the difficulty of getting steel with normal sulphur and phosphorus contents were so great that the following note was added to nearly all of the steel specifications:

"In view of the abnormal difficulty in obtaining materials in time of war, the rejection limits for sulphur in all steels and for phosphorus in acid steels shall be raised 0.01 per cent above the values given in these specifications. This shall be effective during the period of the war and until otherwise ordered by the society."

This year it was decided to remove the privilege extended by this note from 29 of the steel specifications and to retain it on 14 of the specifications. Among the specifications in which the note was retained is that for steel castings.

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On Thursday evening, June 27, the committee on malleable castings rendered its report. It recommended to the society for adoption as standard, the tentative standard specifications for malleable castings. This specification covers malleable iron for railroad, motor vehicle, agricultural instrument, and general machinery castings. It was decided that when the tentative specifications are adopted as standard they will supercede the present standard specifications for malleable iron castings. These specifications are general covering all classes of malleable castings. When they are discarded the society will have no general specifications covering all grades of castings but specifications will be made up for different classes of castings whenever there is a call for them. The new specifications require a tensile strength of 45,000 pounds per square inch and an elongation of 7.5 per cent in 2 inches. This compares with a tensile strength of 38,000 pounds per square inch and an elongation of 5 per cent in 2 inches as required by the old specifications.

At the same session, Harry A. Schwartz, chemist, National Malleable Castings Co., Indianapolis, read a paper in which results of tests showing the physical constants of malleable iron were given.

A written discussion of Mr. Swartz's paper was read by W. R. Bean, Eastern Malleable Iron Co., Nangatuck, Conn. Mr. Bean said that he had record of several thousand tests, which would substantiate what had been given in Mr. Schwartz's paper. He had also made tests on a heavy section of malleable to prove whether it would have good physical properties. A test piece 3 inches square by 12 inches long was annealed in the regular way with light castings. Then nine test pieces were cut from the same section of the bar running lengthwise with the bar; one at each corner, one at each side and one in the center. The bars from the corners had a tensile strength ranging from 45,014 to 45,450 pounds per square inch. The bars from the side ran from 41,489 to 43,866 pounds per square inch in tensile strength, while the center bar which would naturally be expected to be the weakest had a tensile strength of 39,839 pounds per square inch.

A summary was given of tests made on bars which were tested as cast and of duplicate bars which had ⅛-inch machined off the surface. Two bars were cast from each of 58 heats. Those tested in the rough were ⅝-inch in diameter and the machined bars were ¾-inch diameter as cast and turned to ⅝ inch for pulling. The following table gives a summary of the results of these tests:

Condition of bar—Result	Elongation per cent in 2 in.	Tensile strength, lbs. per sq. in.
Rough, maximum	22.0	58,263
Rough, minimum	8.0	51,333
Rough, average	12.8	53,259
Machined, maximum	23.0	60,060
Machined, minimum	8.5	50,241
Machined, average	13.2	53,234

In speaking of machinability of malleable iron, Mr. Bean said, "It should be stated as a fact that, other things being normal, a very high carbon iron can be machined a little more readily than the lower carbon iron, even though all the carbon is in the temper or graphitic form in both instances. Is it, however, proper that quality should be sacrificed for a slight gain in machining speed? This would not be done in steel and other metals."

Another discussion of this paper

was submitted by Enrique Touceda, consulting engineer, Albany, N. Y., who said he believed it would have been of more fully. He pointed out that hardness tests of steels, gray iron and of alloys in general have proved of great method to be of little value except to tell whether a casting has been underannealed. This is due to the fact that

Specifications for Malleable Iron Castings

RECOMMENDED FOR ADOPTION BY THE AMERICAN SOCIETY FOR TESTING MATERIALS AT THE ANNUAL CONVENTION HELD JUNE 24-27, 1919

1—These specifications cover malleable castings for railroad, motor vehicle, agricultural implement, and general machinery purposes.

I. Manufacture

2—The castings shall be produced by either the air-furnace, open-hearth, or electric-furnace process.

II. Physical Properties and Tests

3—The tension test specimens specified in Section 5 shall conform to the following minimum requirements as to tensile properties:

Tensile strength, lb. per sq. in.	45,000
Elongation in 2 in., per cent	7.5

4—(a) All castings, if of sufficient size, shall have cast thereon test lugs of a size proportional to

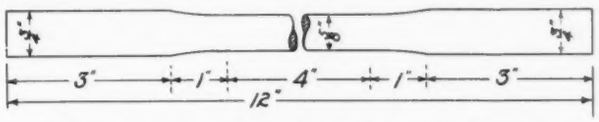


FIG. 1—STANDARD TEST BAR FOR MALLEABLE CASTINGS

the thickness of the casting, but not exceeding 5/8 by 3/4 inch in cross-section. On castings which are 24 inches or over in length, a test lug shall be cast near each end. These test lugs shall be attached to the casting at such a point that they will not interfere with the assembling of the castings, and may be broken off by the inspector.

(b) If the purchaser or his representative so desires, a casting may be tested to destruction. Such a casting shall show good, tough malleable iron.

5—(a) Tension test specimens shall be of the form and dimensions shown in Fig. 1. Specimens whose mean diameter at the smallest section is less than 1/2 inch, will not be accepted for test.

(b) A set of three tension test specimens shall be cast from each melt, without chills, using heavy risers of sufficient height to secure sound bars. The specimens shall be suitably marked for identification with the melt. Each set of specimens so cast shall be placed in some one oven containing castings to be annealed.

6—(a) After annealing, three tension test specimens shall be selected by the inspector as representing the castings in the oven from which these specimens are taken.

(b) If the first specimen conforms to the specified requirements, or if, in the event of failure of the first specimen, the second and third specimens conform to the requirements, the castings in that oven shall be accepted, except that any casting may be rejected if its test lug shows that it has been properly annealed. If either the second or third specimen fails to conform to the requirements, the entire contents of that oven shall be rejected.

7—Any castings rejected for insufficient annealing may be reannealed at once. The reannealed castings shall be inspected and if the remaining test lugs, or castings broken as specimens, show the castings to be thoroughly annealed, they shall be accepted; if not, they shall be finally rejected.

III. Workmanship and Finish

8—The castings shall conform substantially to the patterns or drawings furnished by the purchaser, and also to gages which may be specified in individual cases. The castings shall be made in a workmanlike manner. A variation of 1/8 inch per foot will be permitted.

9—The castings shall be free from injurious defects.

IV. Marking

10—The manufacturer's identification mark and the pattern numbers assigned by the purchaser shall be cast on all castings of sufficient size, in such positions that they will not interfere with the service of the castings.

V. Inspection and Rejection

11—(a) The inspector representing the purchaser shall have free entry, at all times while work on the contract of the purchaser is being performed, to all parts of the manufacturer's works which concern the manufacture of the castings ordered. The manufacturer shall afford the inspector, free of cost, all reasonable facilities to satisfy him that the castings are being furnished in accordance with these specifications. All tests and inspection shall be made at the place of manufacture prior to shipment, unless otherwise specified, and shall be so conducted as not to interfere unnecessarily with the operation of the works.

(b) The manufacturer shall be required to keep a record of each melt from which castings are produced, showing tensile strength and elongation of test specimens cast from such melts. These records shall be available and shown to the inspector whenever required.

12—Castings which show injurious defects subsequent to their acceptance at the manufacturer's works may be rejected, and, if rejected, shall be replaced by the manufacturer free of cost to the purchaser.

interest to the engineer and consumer if Mr. Schwartz had entered into the question of hardness tests for malleable value and are widely used. But with malleable he regards the hardness test by either the Brinell or the scleroscope the skin, which has the greatest effect on the machining qualities must be removed before making hardness test.

Physical Constants for Malleable

Numerous Tests Contribute Data on Characteristics of Malleable Iron—Tensile Strength Investigated in its Relation to Chemical Composition—Effect of Heat on Dimensions and on Tensile Strength Explained

BY H. A. SCHWARTZ

MALLEABLE cast iron is made by producing castings containing all their carbon in the combined state, and then securing complete conversion of the carbon into the free state by suitable heat treatment at a temperature considerably below the melting point. The material consists of a ferrite matrix through which the carbon is distributed in the temper or amorphous form. Its properties are therefore dependent upon the physical properties of the ferrite and upon the amount and geometric form of the included carbon. Consequently the physical constants of malleable cast iron will vary with the chemical composition and heat treatment of the material.

Only tensile strength has been investigated in very great detail in its relation to chemical composition. This work involved a critical study of the chemical and physical properties of many thousands of heats. The result of this investigation is of importance in the present connection only to the extent that it corroborates the conclusion that the amount and form of the free carbon present is the determining factor as regards to quality of the malleable iron which is produced.

Paper presented at the annual meeting of the American Society for Testing Materials held in Atlantic City, June 27, by H. A. Schwartz, chemist, National Malleable Castings Co., Indianapolis.

The tests upon which this paper is based were made on material of such a character as to pass the present specifications satisfactorily, and may be understood as applying to a commercial product of that character. Furthermore they have all been made upon test specimens which are known to be free from defects such as shrinks or blowholes, but are not based upon material of superior quality.

For the purpose of the author's investigation it was usually necessary to provide test specimens of more accurate form than can be made by even the most careful molding practice. It was possible either to machine the test specimen after annealing, thereby introducing such an error as may result from the rejection of the surface metal; or to grind the test specimen to size before annealing, thereby incurring a laborious and expensive method of preparation. Both means were used in preparing the specimens, dependent upon the individual circumstances.

The tensile properties of malleable cast iron are the only constants now defined by specification. The value assigned for tensile strength is 45,000 pounds per square inch and the elongation required is 7½ per cent in 2 inches. From observation on tests covering many thousands of heats, the author is of the opinion that the product made by reputable foundries to pass the specifications of the American Society for Testing Materials will actually average from 48,000 to 50,000 pounds per square inch in tensile strength, and will have an elongation in 2 inches of 10 to 15 per cent.

The stress-strain diagram shown in Fig. 1 is selected as typical, since it conforms in properties rather closely to the values assigned by specifications. It is plotted from extensometer readings on a test specimen 0.505 inch in diameter, 5 inches long between gage points, machined from a large casting. This test was made by Prof. Harold A. Thomas of the Rose Polytechnic institute in September, 1918. This specimen is of interest in that it indicates the very satisfactory qualities that can be obtained on a test specimen machined from a large casting after annealing. The block from which this specimen was obtained was 4½ x 9 x 14 inches when cast.

The reduction of area was not determined. A number of tests were made, however, on specimens ground to size before annealing. From these the following results are typical:

Tensile strength pounds per square inch	Elongation in 2 inches Per cent	Reduction in area Per cent
55,200	19	18
55,100	13	20
55,200	17	23

Fig. 2 has been prepared to record the fact that malleable cast iron

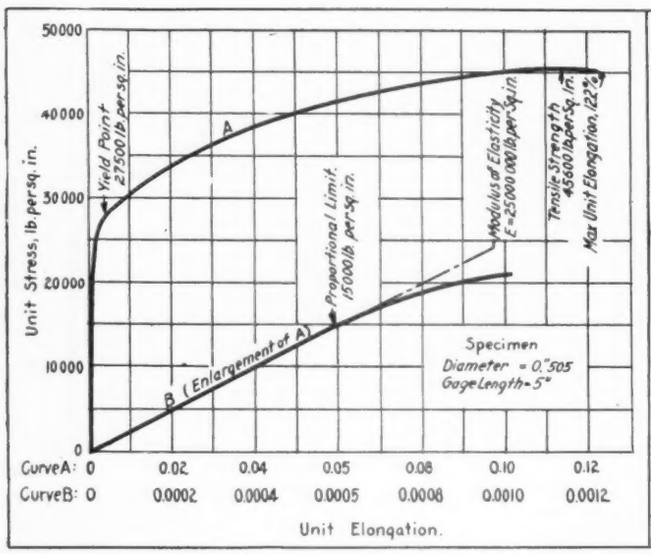

50000
40000
30000
20000
10000
0
Unit Stress, lb per sq. in.
Yield Point 27500 lb per sq. in.
A
Proportional Limit. 15000 lb per sq. in.
Modulus of Elasticity E = 25000 000 lb per sq. in.
Tensile Strength 45600 lb per Sq. in.
Max Unit Elongation, 22%
B (Enlargement of A)
Specimen
Diameter = 0.505
Gage Length = 5"
Curve A: 0 0.02 0.04 0.05 0.08 0.10 0.12
Curve B: 0 0.0002 0.0004 0.0005 0.0008 0.0010 0.0012
Unit Elongation.

FIG. 1—STRESS-STRAIN DIAGRAM OF MALLEABLE CAST IRON IN TENSION

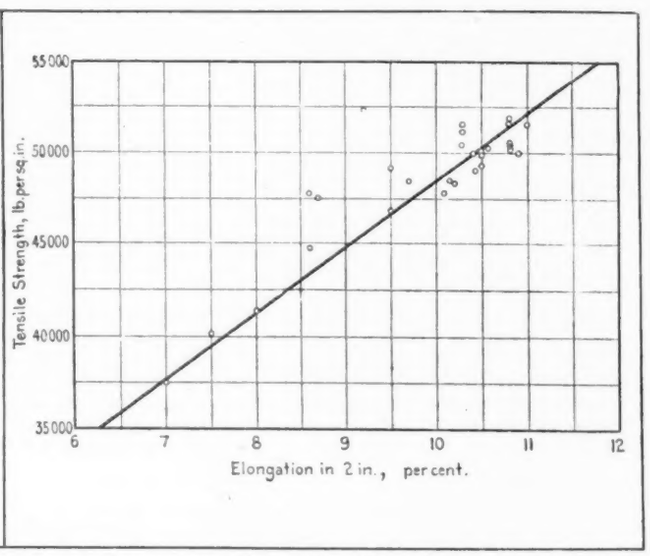


FIG. 2—RELATION BETWEEN TENSILE STRENGTH AND ELONGATION OF MALLEABLE CAST IRON

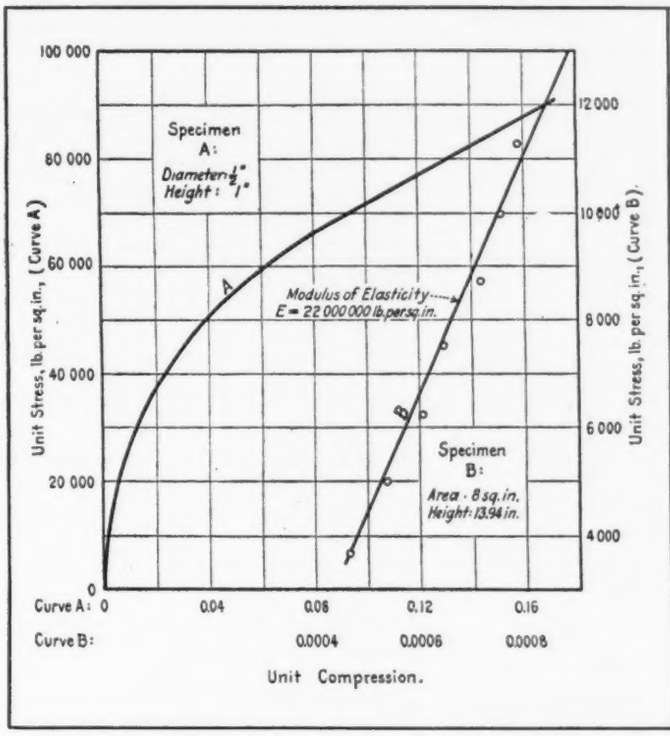


FIG. 3—STRESS-STRAIN DIAGRAM OF MALLEABLE UNDER COMPRESSION

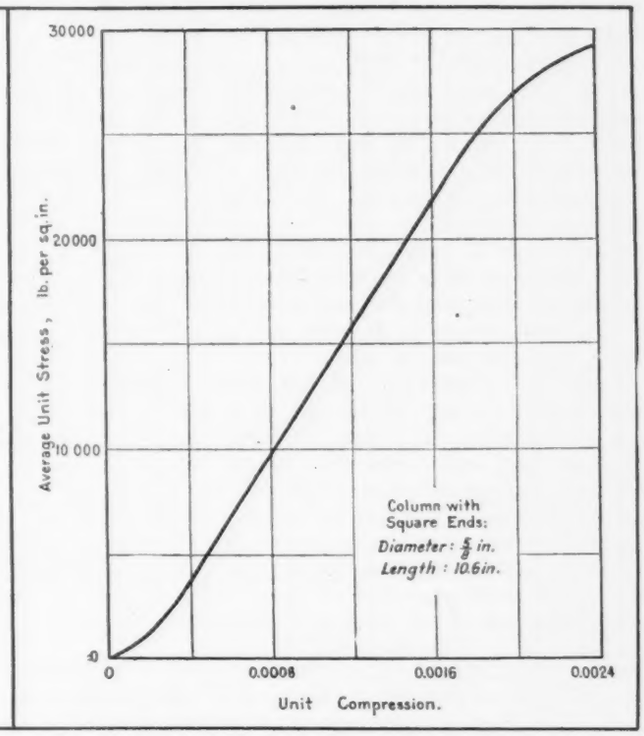


FIG. 4—STRESS-STRAIN DIAGRAM OF MALLEABLE AS A STRUT

differs from all other commercial iron alloys, in that its elongation increases with its tensile strength. Each point on this graph indicates the tests of a group of heats of the same chemical composition, representing in all 840 heats. The tensile strength is indicated on the vertical ordinate while the elongation is noted horizontally.

From the nature of the material the ultimate strength in compression is rather vague, for actual failure may never occur, the material merely flowing out indefinitely with increase of load.

Fig. 3, curve *A*, indicates the stress-strain diagram as determined on a test specimen ½-inch in diameter and 1 inch high. It will be noted that the material has not actually failed, though it has been compressed to a point probably equivalent to the destruction of any actual structural detail. The tests were not sensitive enough definitely to determine the proportional limit, which, however, seems to be not far from 15,000 pounds per square inch.

Curve *B* is a similar diagram made on a cylindrical specimen of the material whose tensile properties are plotted in Fig. 1, having a cross-sectional area of 8 square inches and a height of 13.94 inches. The proportional limit has not been reached at the maximum load obtained in this test, 12,500 pounds per square inch. The conclusion seems war-

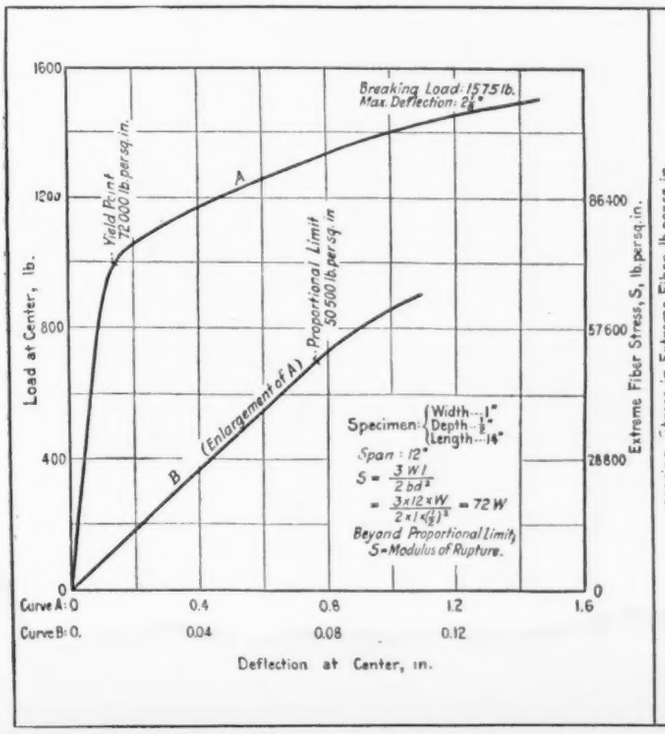

Breaking Load: 1575 lb.
Max. Deflection: 2⅛"
Yield Point 72 000 lb. per sq. in.
Proportional Limit 50 500 lb. per sq. in.
(Enlargement of A)
Specimen: Width 1" Depth ½" Length 14"
Span: 12"
S = 3Wl / 2bd²
= 3 × 12 × W / 2 × 1 × (½)² = 72 W
Beyond Proportional Limit, S = Modulus of Rupture.
Load at Center, lb.
Extreme Fiber Stress, S, lb. per sq. in.
Curve A:
Curve B:
Deflection at Center, in.

FIG. 5—STRESS-DEFLECTION DIAGRAM OF MALLEABLE IN CROSS BENDING

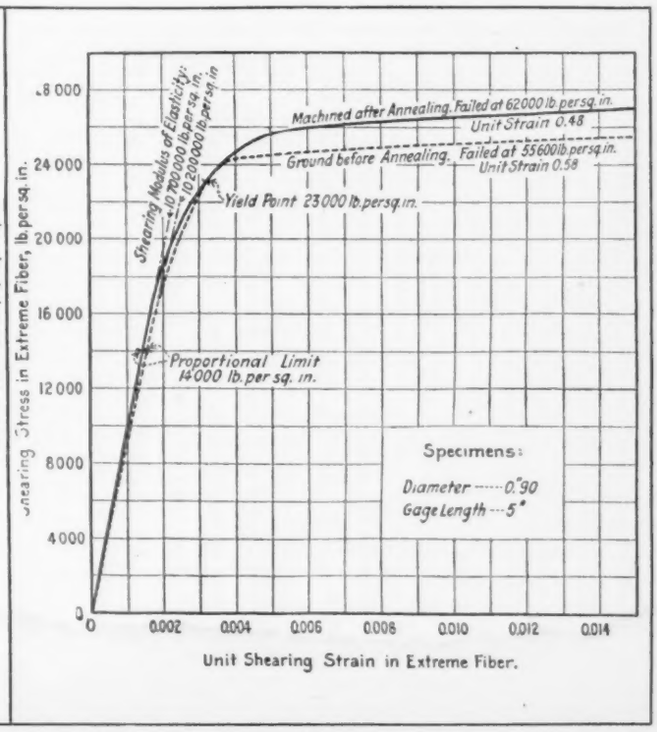

Machined after Annealing. Failed at 62000 lb. per sq. in.
Unit Strain 0.48
Ground before Annealing. Failed at 55600 lb. per sq. in.
Unit Strain 0.58
Yield Point 23000 lb. per sq. in.
Shearing Modulus of Elasticity:
= 10 700 000 lb. per sq. in.
= 10 200 000 lb. per sq. in.
Proportional Limit 14000 lb. per sq. in.
Specimens:
Diameter 0.90
Gage Length ... 5"
Shearing Stress in Extreme Fiber, lb. per sq. in.
Unit Shearing Strain in Extreme Fiber.

FIG. 6—STRESS-STRAIN DIAGRAM OF MALLEABLE IN TORTION

ranted that the elastic properties of the material in tension and in compression are approximately the same.

The data given under compression applies only to structural details in which the length is not large as compared with the diameter.

In order to give some idea as to the behavior of details in the form of columns made of malleable iron, a few tests were undertaken on specimens ⅝-inch in diameter and 10.6 inches long, having ends of such a form as to cause the specimen to behave as a column with square ends. In Fig. 4 is given a stress-strain diagram which is the average of tests on three different specimens of this character. Time has been lacking to make a sufficently extended series of experiments to determine the application of Gordon's or similar formulas to malleable cast iron strut members.

Specifications R 17 of the United States railway administration, dated May 1, 1918, provide that the material in the form of bars 1 inch wide on supports 12 inches apart shall support certain specified loads at the center varying with the thickness of the bar but all corresponding fairly closely to the value 64,000 pounds per square inch for the modulus of rupture of the material. It is believed that material passing the tensile test requirements of the American Society for Testing Materials invariably exceeds this requirement for modulus of rupture.

Fig. 5 is a stress-deflection diagram obtained on an unmachined specimen

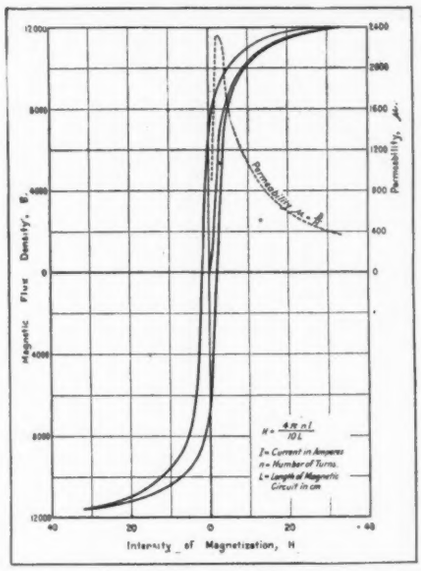

Magnetic Flux Density, B
Permeability, μ
Intensity of Magnetization, H
Permeability μ = B/H
H = 4πnI/10L
I = Current in Amperes
n = Number of Turns
L = Length of Magnetic Circuit in cm

FIG. 7—MAGNETIZATION CURVE OF MALLEABLE CAST IRON

½ x 1 x 14 inches loaded at the center of a 12-inch span.

The data bearing on shearing stresses are based on a series of experiments conducted in co-operation with Professor Thomas at the Rose Polytechnic institute in January, 1919. The tests were made both by punching a round hole 1 inch in diameter through plates approximately ¼-inch thick which had not been machined, and by subjecting round pins ⅞-inch in diameter to double shearing. The pins were finished to size. Duplicate specimens were tested in order to compare the shearing stress in pins machined after annealing with the same constant determined on specimens ground to size before annealing.

Specimens for each of the three tests were available from the same metal. The average shearing stresses in pounds per square inch were as follows: By punching, 45,152; by shearing finished pin, 40,340, and by shearing pin ground before annealing, 41,350. At the time the shearing experiments were made, two specimens of the same material were also subjected to a torsion test. The samples were approximately 0.90-inch in diameter and 5 inches long between gage points. One specimen was ground to size before annealing, the other turned to size after annealing. Stress-strain diagrams from the two tests are given in Fig. 6.

The Brinell hardness of malleable cast iron has been observed to range from 101 to 145, the average value being approximately 110. Shore scleroscope readings on malleable iron with a Brinell hardness of 102 will average about 15. All attempts made to correlate the Shore and Brinell hardness with machining quality have been entirely without success. The Brinell number varies approximately with the tensile strength, and inversely with the carbon content of the material, as should be expected.

The magnetic properties of the product have been rather extensively studied by the National Malleable Castings Co., both in its own electrical laboratory and before that time in co-operation with Dr. E. S.

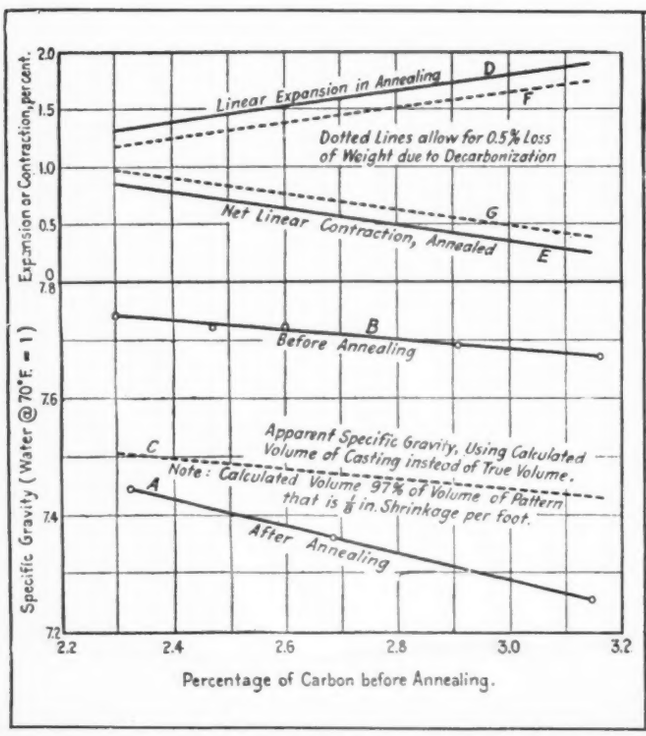

Specific Gravity (Water @ 70°F. = 1)
Expansion or Contraction, percent.
Linear Expansion in Annealing
D
F
Dotted Lines allow for 0.5% Loss of Weight due to Decarbonization
G
Net Linear Contraction, Annealed
E
B
Before Annealing
Apparent Specific Gravity, Using Calculated Volume of Casting instead of True Volume.
C
Note: Calculated Volume 97% of Volume of Pattern that is ⅛ in. Shrinkage per foot.
A
After Annealing
Percentage of Carbon before Annealing.

FIG. 8—SPECIFIC GRAVITY OF MALLEABLE CAST IRON

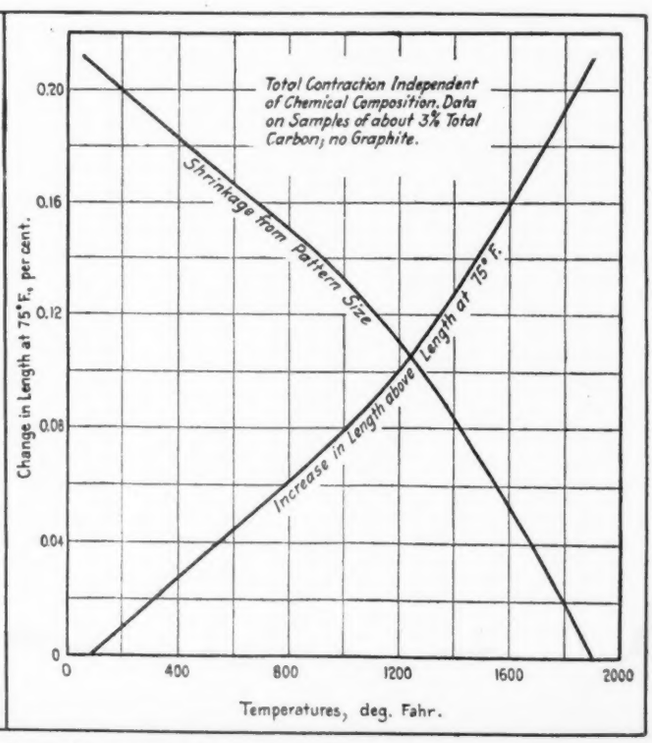

Total Contraction Independent of Chemical Composition. Data on Samples of about 3% Total Carbon; no Graphite.
Shrinkage from Pattern Size
Increase in Length above Length at 75°F.
Change in Length at 75°F., per cent.
Temperatures, deg. Fahr.

FIG. 9—SHRINKAGE OF WHITE CAST IRON

Johnnott at Rose Polytechnic institute. The magnetization curve and hysteresis loop shown in Fig. 7 are plotted from some of the earlier observations. The test was made on a ring-shaped specimen having a cross-section about 1 inch square and a mean diameter of about 4 inches. The specific resistance of a single average sample of the product has been determined as 0.000041 ohms per centimeter cube at 75 degrees Fahr.

Malleable iron varies in density with the percentage of carbon. Fig. 8, curve *A*, shows the variation of specific gravity referred to the carbon content of the original hard iron. The samples from which these data were obtained may be expected to be approximately 0.5 per cent lower in carbon than the original hard iron. The utmost care was taken to avoid any shrinkages, blowholes or other mechanical defects in the samples.

In case the density is to be used for the computation of the weight of a casing of a given design, curve *A* is not directly applicable. Malleable castings from a given pattern vary somewhat in size. This variation arises from differences in carbon content and heat treatment. All graphite-free iron castings shrink exactly the same amount. This fact has been very carefully checked by the National Malleable Castings Co. by measurements of the contraction in freezing and cooling off alloys differing much more widely in chemical composition than is possible in commercial malleable cast iron. The unannealed castings from a given pattern are always of the same volume. When annealed they expand a variable amount depending upon heat treatment and chemical composition. Therefore, if the original hard iron were always of the same density the variation in specific gravity would be compensated by the corresponding change in volume, and the weight of the castings would all be the same even though they would be of different dimensions.

Specific Gravity Variations

The specific gravity of white cast iron varies with its chemical compositions as shown in Fig. 8, curve *B*. These results again are based upon samples known to be free from defects. The dotted line *C* in this figure indicates the specific gravity as referred to the expected volume of the casting made on the commercial assumption that the shrinkage of the white iron is ¼-inch per foot and that the *net* shrinkage of the malleable casting is ⅛-inch per foot. This curve, therefore, compensates for that portion of the change in density which is allowed for in weight by a corresponding variation of volume in the casting.

Curve *D* in this figure plots the expansion in annealing corresponding to the differences of density existing between curves *A* and *B*. Curve *E* is the difference between curve *D* and 2.14 per cent, the observed shrinkage of all white cast iron. This graph is lower than the usual commercial allowance of ⅛-inch per foot corresponding to 1 per cent now commonly used. Curves *F* and *G* correspond to curves *D* and *E* allowing for the decrease in weight by decarburization.

Malleable cast iron being a mechanical mixture of iron and carbon, has as its specific heat the average of the specific heats of the two ingredients in the proportions in which they exist in the malleable iron. The curve in Fig. 11 plots the specific heat of a mixture of 98 per cent iron and 2 per cent carbon. The results are in error to the extent that the specific heat of carbon as temper carbon is not known, and the graph is based on the specific heat of diamond. It is believed that this curve is as nearly accurate as a repetition of the work on malleable samples would have been and no attempt has, therefore, been made in our laboratories to improve upon these observations.

The National Malleable Castings Co. has had occasion to design and build special equipment for the determination of changes in dimensions of castings both during the process of annealing and while freezing in the mold. In connection with these experiments there have been rendered available figures from which the expansion of malleable iron and hard iron with heat can be obtained. Fig. 10 is a graph indicating the increase in length of a malleable bar with increasing temperature.

Fig. 9 shows the results of a typical experiment to determine the shrinkage of the original white cast iron. As previously pointed out in connection with the discussion of the density of malleable cast iron, all graphite-free iron castings shrink the same amount in freezing in the mold. They not only shrink the same amount, but also the form of curve correlating temperature and shrinkage is practically the same in all cases. The shrinkage curve of Fig. 9 is an average of closely agreeing results of six materials of rather widely different compositions, including both normal hard irons and others of compositions far beyond those encountered in commer-

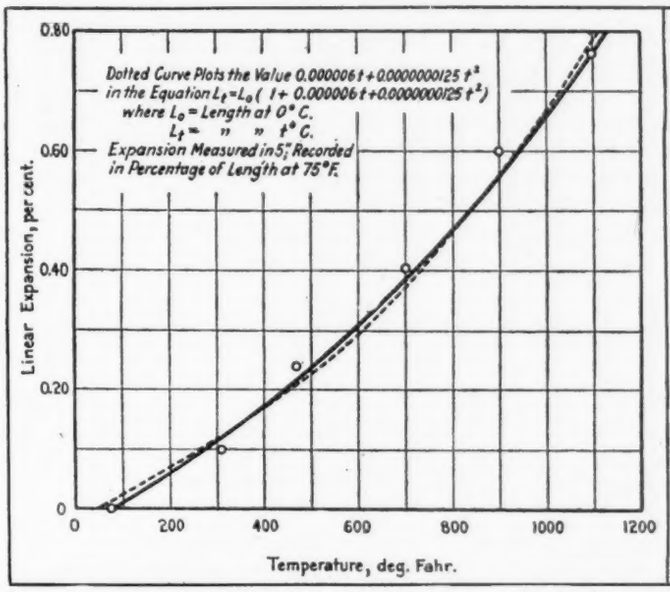


FIG. 10—EXPANSION DIAGRAM OF MALLEABLE CAST IRON

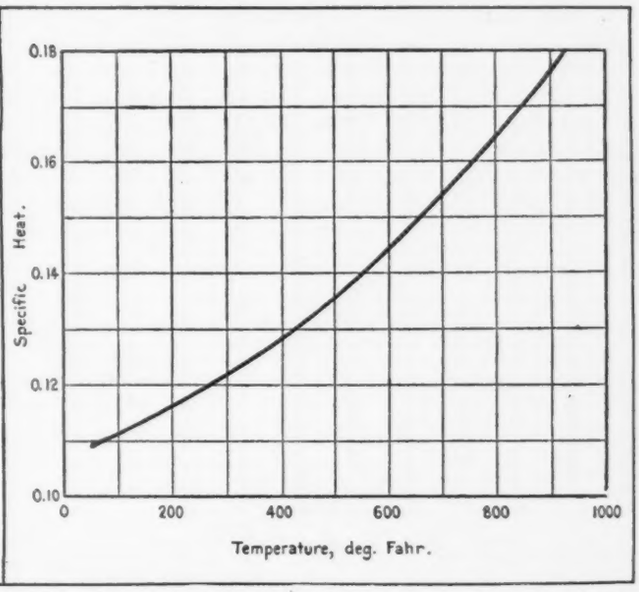


FIG. 11—SPECIFIC HEAT OF MALLEABLE ESTIMATED AS 98 PER CENT IRON AND WITH 2 PER CENT CARBON

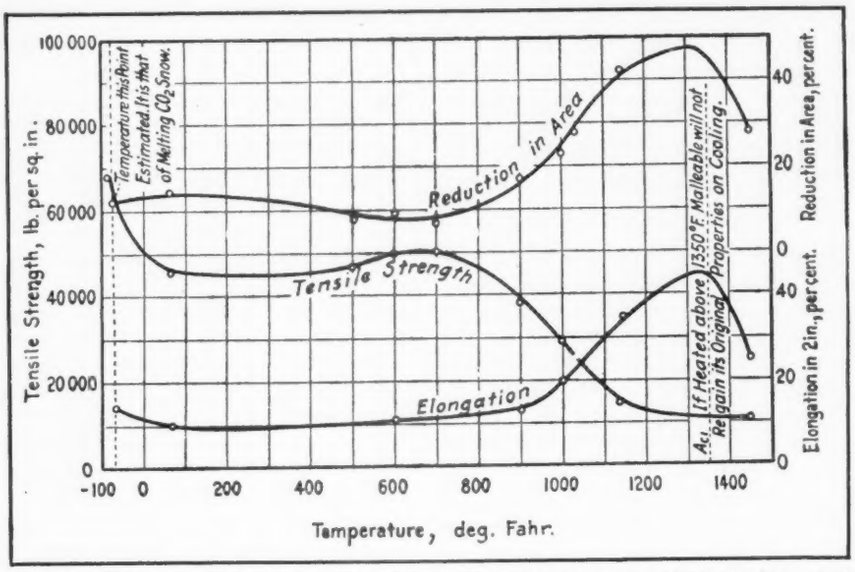


FIG. 12—EFFECT OF TEMPERATURE UPON THE TENSILE PROPERTIES OF MALLEABLE CAST IRON

cial malleable practice. Experiments were conducted on specimens 36 inches long, readings being accurate to about 0.002 inch. The curve for expansion is merely the inverse of the shrinkage curve. It will be noted that the curves do not go quite to the melting point. They go, however, to that temperature at which contraction appeared to begin. Most of the white cast iron samples appeared to occupy an interval just below the melting point in which no observable contraction took place. Inasmuch as the apparatus used recorded the expansion taking place in gray iron just below the freezing point, it is assumed that no such expansion took place in the case of white iron.

In connection with investigations in regard to annealing heat treatments, the National Malleable Castings Co. has from time to time determined the critical points of various alloys. The experiments are not of extreme precision, but for the sake of completeness of results are included here:

	Malleable Cast Iron		Hard Iron	
	Fahr.	Cent.	Fahr.	Cent.
	Degrees		Degrees	
Ac_1	1356	735.5	1350	732.5
Ar_1	1283	695.0	1280	693.5

Our experiments were not sufficiently sensitive to indicate A_2 and A_3 in malleable iron.

Fig. 12 shows the tensile strength, elongation and reduction in area of malleable cast iron tested at various temperatures. Tests were conducted upon specimens 0.634-inch in diameter, ground to size before annealing. All the specimens were of the same material and of the same heat treatment. The elongation is measured in a gage length of 2 inches. The results are known to be unaffected by shrinkage or other defects. The last observation at 1450 degrees Fahr. indicates the change of properties caused by the re-solution of carbon at temperatures above the critical point. There is little change in strength between 100 and 400 degrees Fahr.

Graphitization in Annealed Cast Iron

A PAPER on graphitization of cast iron upon annealing has been prepared by Paul D. Merica and Louis J. Gurevich, bureau of standards, Washington, to be read at the Chicago meeting of the American Institute of Mining and Metallurgical Engineers in September. The authors give the results found on annealing samples of gray iron and white iron of different compositions at temperatures ranging from 600 to 1120 degrees Cent. One set of samples was annealed for six hours and another for 48 hours.

The practical application sought was to acquire information which could be applied to the annealing of chilled car wheels. The conclusions of the authors are summed up in the four following statements:

The annealing or graphitization ranges of temperatures were determined for three different compositions used for car wheels. The temperature of initial precipitation of temper carbon for six hours of annealing was not noticeably affected by variation of sulphur content from 0.10 to 0.20 per cent or by variation of total carbon content from 3.60 to 3.90 per cent, although the effect of greater carbon content is to narrow the temperature range within which graphitization is complete.

The temperature of beginning precipitation of temper carbon was about 830 degrees for the six-hour period of annealing, and about 730 degrees Cent. for the 48-hour period. The maximum allowable temperature, therefore, for the annealing, or *pitting* of car wheels is about 730 degrees Cent.

After complete decomposition of all free cementite by annealing at from 1000 degrees to 1100 degrees Cent. and cooling at equal rates in a laboratory electric furnace, less graphite is found in a specimen cooled from 1100 degrees than in one of the same composition cooled from 1000 degrees Cent. This indicates that graphite separates directly from solid solution upon cooling, when its nuclei are already present.

The fact that only 0.20 per cent of combined carbon was found in some specimens after annealing at high temperatures and cooling slowly in the furnace would indicate either that the graphite eutectoid lies at much lower values of carbon content than has been previously supposed, that there is at those rates of cooling a direct precipitation of graphite eutectoid, or that there is a formation of graphite from pearlite at temperatures directly below that of its formation.

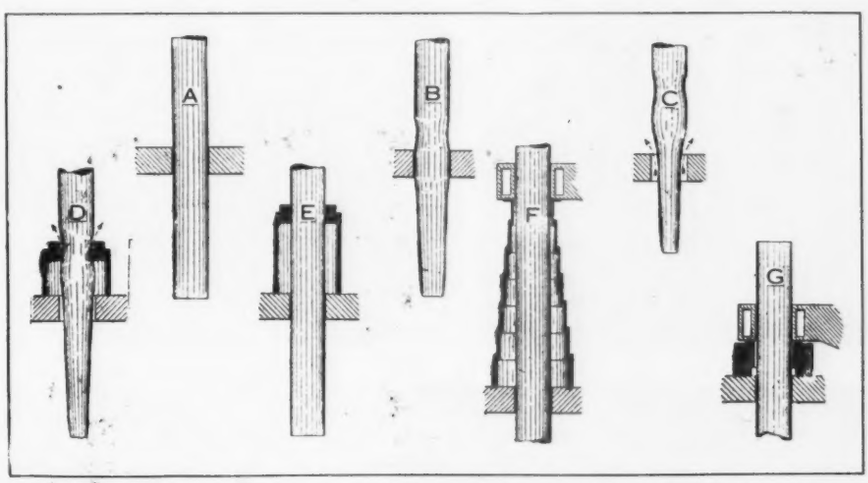
Merge Two Foundries

The Acme Foundry Co. and the Palmers & DeMooy Foundry Co., Cleveland, were merged on July 1 into a new company which is known as the Acme-Palmers & DeMooy Foundry Co., with a capitalization of $400,000. The Acme Foundry Co. was organized 20 years ago by William Greenbaum, C. K. Sunshine and L. G. Kraus, and has been managed by Mr. Greenbaum since that time. The Palmers & DeMooy Foundry Co. was formed 37 years ago by V. T. Palmer, William DeMooy and George H. Palmer and for the past years has been under direction of W. B. Greene, its secretary and treasurer. The new company is headed by W. B. Greene, president, and William Greenbaum, secretary and treasurer. For the present operations will be concentrated at the Acme plant, which will be enlarged and improved to handle additional light gray-iron casting work.

Preventing Oxidation of Electrodes

Several Devices Are Recommended to Stop Circulation of Gases Through Clearances Between Roof of Furnace and the Electrodes—Some Are Fixed While Others Telescope When Electrodes Move Down

SOME interesting facts regarding electrodes were brought out in a paper on large electric steel-melting furnaces read recently at a joint meeting of the British Institute of Electrical Engineers and the British Iron and Steel institute by Victor Stobie. The author brings out the point that the main wear on electrodes in ordinary electric steel furnaces does not take place at the arc but results from the surface burning of the carbon all over those parts of the electrodes which are inside the melting chamber and up to a point about 15 inches above the roof. On looking inside most furnaces the electrodes will be seen to be considerably tapered from where they enter the roof. Fully 75 per cent of the electrodes are wasted here. It is thought by some people not acquainted with electric furnace practice that there is always a reducing atmosphere inside electric furnaces of the older types in use. This is an utterly mistaken notion, which is proved by the ease with which the raw materials charged into such furnaces oxidize, even without the help of iron ore or other solid oxidizing agents.



ILLUSTRATIONS OF THE EFFECTS OF OXIDATION ON ELECTRODES WITHOUT SPECIAL PROTECTION AND WITH VARIOUS ECONOMIZERS

The cause of the oxidizing atmosphere inside the older electric furnaces lies in the crude method of feeding the electrodes into the melting chamber. This is usually done by leaving in the roof a number of plain holes equal to the number of electrodes which have to be fed continuously into the furnace; the bricks forming such holes support annular water-jackets which fit new electrodes with a small clearance. The heated gases inside the furnace continuously pass up those clearance spaces between the roof and the electrodes. The results are serious. The hot gases cause the clearance to be rapidly increased by burning away the electrodes; all the heat value of the gases and flames which are constantly pouring out of the furnace through the electrode holes is wasted; the duration of a heat is lengthened in proportion to the heat lost through the roof holes; and the undue heating necessitates water cooled electrodes.

At first sight it may seem a simple matter to close up the clearance between the roof of a furnace and the electrodes passing through it but this is not so, as is illustrated by the fact that there have been few, if any, devices developed for this purpose. The author proposes a device which he has found to be successful in preventing the wasting away of the electrode by oxidizing gases.

Gases Cannot Escape

Observations showed that at about two feet above the roof in most furnaces the electrodes, even when raised for charging, are seldom at a temperature at which they can burn; therefore, that is the only point at which a permanently good seal can be made round the electrodes. If an electrode is closed hermetically from the roof up to that point, the burning away of the electrode and the escape of the heated gases from the furnace are prevented.

In practice, a light metal cylinder a few inches larger in diameter than the electrode and about two feet in length is fixed on the roof around each electrode. The top end of this jacket is covered with a sealing plate which prevents the passage of the flames, the electrode passing through a neatly fitting hole in the center of such a cover. Another form of economizer, as this device is termed, has been developed for use on furnaces which have only a short electrode travel. It is sealed to the electrode in the same way as the economizer just described but differs from it in having a telescopic tube around the electrode. In the accompanying illustration *A* shows a new electrode in a roof; *B*, a used electrode burned away inside of the furnace and above the roof; *C*, a burned electrode raised for a fresh charge; *D*, ineffectiveness of seal 12 inches above roof, due to burning away in air of red-hot electrode; *E*, seal 24 inches above roof where it is maintained because the electrode does not get red hot above this point; *F*, telescopic economizer extended; and *G* telescopic economizer closed.

Steel Casting Pin Holes

By H. E. Diller

Question:—Recently we have been noticing pin holes in our steel castings. Will you please tell us what is the cause of these holes and how to prevent them?

Answer:—Pin holes are caused by the metal being over-oxidized or by damp sand. We would suggest that you pour a test piece in a steel mold, 1 x 4 inches at the bottom, 2 inches high and with sloping sides so that you can easily knock the test piece out. When the test piece sets, cool it in water and break it. If the metal does not set quietly and the fracture shows over-oxidation as indicated by gas holes, you should add more deoxidizer to the bath. The same result might be obtained by a deoxidizer in the ladle.

FIG. 1—RUDDER FRAME CASTING OF THE TYPE USED IN THE CONSTRUCTION OF BATTLESHIPS WASHINGTON AND COLORADO—FIG. 2—DRAG SECTION OF BATTLE SHIP RUDDER FRAME MOLD SHOWING ARRANGEMENT OF THE CORES—FIG. 3—STERN POST FOR 8800-TON MERCHANT VESSEL OF THE TYPE BEING BUILT BY THE MERCHANT SHIPBUILDING CORP., HARRIMAN, PA.—FIG. 4—DRAG SECTION OF BATTLESHIP STERN POST MOLD AFTER REMOVAL OF DRAWBACKS

Eastern Plant Makes Ship Castings

Heavy Castings for Stern Frames, Anchors, Rudders and Stems Require Accurate Patterns and Unusual Care in Molding—Special Methods Are Employed in Both Large and Small Parts

BY E. C. KREUTZBERG

FOR many years, Chester, Pa., has furnished a high per cent of the marine steel castings employed in ship construction in this country. Due to its location at tidewater on the Delaware river, concentration on this branch of the casting industry has been an entirely natural development on the part of the steel foundries of that city. Chester now has capacity for producing the smallest as well as the largest marine steel castings, including stern frames and anchors for battleships of the dreadnaught type. As a result of its pre-eminence in this field, it was to Chester that the government turned, during the war, for many of the heavy castings required for the construction of government ships, both naval and merchant, at eastern yards.

Among the plants which are doing the bulk of the work of this character at Chester is that of the Penn Seaboard Steel Corp. First erected in 1892, this establishment since its inception has been devoted to the production of steel castings generally, but has specialized in parts for locomotives and ships. The needs of the government during the war necessitated expansion in locomotive and, particularly, marine work. As a result, the company last year erected a second casting shop, 92 x 380 feet. In its two shops it now is producing all the important steel castings, including stern posts, anchors, struts, stems, after ends, rudders, forward ends, etc., used in vessel construction by the American International Shipbuilding Corp., the Sun Shipbuilding Co., the Merchant Shipbuiding Corp., the Traylor Shipbuilding Co., the New York Shipbuilding Corp., the Chester Shipbuilding Co., the Charlestown navy yard, and other yards. Perhaps the most interesting of the castings of this kind recently produced by the Penn Seaboard Steel Corp., are the stern posts and rudder frames for the battleships WASHINGTON and COLORADO, which now are under construction at the yard of the New York Shipbuilding Corp. The casting of the rudder frames for each of these ships proved a complicated and exacting task.

As shown in Fig. 1, a rudder frame is an unusually irregular casting. It is a skeleton to which plates later may be riveted, thus resulting in a much lighter rudder than if the whole piece were cast solid. The sections of metal in the castings vary from 1¼ to 8 inches in thickness, and the area in which the metal must flow is unusually large. Therefore, one of the principal problems is that of locating the heads and gates. These are seven and two in number, respectively, which is unusual for a casting of this size. The mold, shown in Fig. 2, is put up in a 15 x 26-foot flask, to which is joined a 6 x 14-foot box. The drag, both in the main flask and box, is 4 feet deep, while the cope is 24 inches thick. In putting up the mold, a bed is swept with a form taken from the pattern, after which the pattern is placed on the bed. Precautions must be taken to have all parts of the pattern in perfect alignment, since a rudder frame casting, after being finished, must fit accurately to the stern post. Hence, no warping or variation of any kind in the casting is permissible.

The pattern is solid and the mold is rammed entirely in the drag. The mold is located in a pit and is cast on the molding floor; the drying is done with an oil flame which has an underground combustion chamber.

One of the noteworthy features of these castings is the unusually large portion of the mold which is comprised of cores. The cores, 30 in number, are made in boxes in the usual way and vary in size. In order

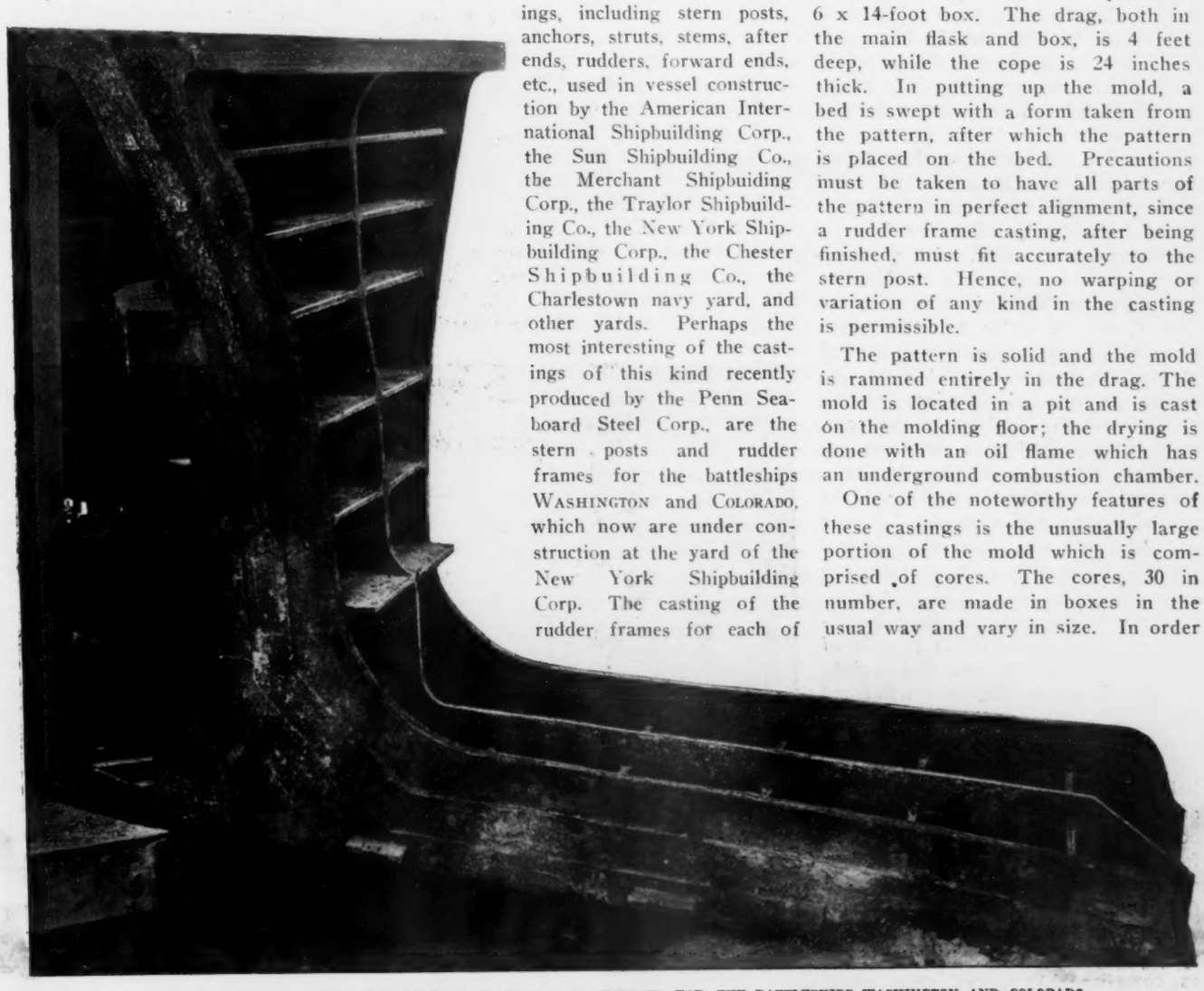


FIG. 5—FINISHED STERN POST CASTING OF THE TYPE DESIGNED FOR THE BATTLESHIPS WASHINGTON AND COLORADO

FIG. 6—READY TO RAM DRAG SECTION OF MERCHANT SHIP STERN POST MOLD—PATTERN IS SHOWN IN THE SAND

to minimize resistance to the tremendous forces of shrinkage in a casting of this size and design, they are made hollow. The walls of these cores are 10 to 12 inches thick, and the hollow portions are filled with moist green sand which is loosely packed. As a result, the walls of the cores recede with the pressure of the metal as it contracts. Further provision for avoiding cracking or warping of the casting during shrinkage is made by loosening the sand from the gates and risers. This is done immediately after pouring, by cutting away the sand with a powerful stream of water. In addition to cutting away the sand from the gates and risers, in order to allow both ends of the casting to contract toward the center, water is applied to the moist green sand interiors of the cores, through openings in the cope, in order still further to cut down the amount of resistance in the core. Adequate provision is made, by the use of cinders and openings, for ventilating the mold. The mold is not opened until after the casting has been cooled.

For pouring each of these battleship rudder frames, 66,030 pounds of steel was required and the weight of each of the castings when finished and ready to ship averaged 56,000 pounds. For putting up each mold, the labor of three molders and two helpers for two weeks was required and the production of each set of cores absorbed the time of four men for four days. To chip each casting required the attention of one man for 60 hours.

Castings which require a mold of a different character, although fully as complicated, are the stern posts for the battleships WASHINGTON and COLORADO. These were produced in a 15 x 18-foot flask, having an 8-foot drag and a 24-inch cope. These castings not only are irregular in form, but the sections of metal vary all the way from ¾-inch to 6 inches in thickness. Because the casting conforms to the shape of the battleship stern, it was necessary to provide the mold with eight drawbacks. These were arranged in two tiers, three on the bottom and five on the top. After drawing the top of the pattern and lifting off the top section of drawback plates, the center section of the pattern was drawn. After that, the bottom tier of drawbacks was removed and the bottom section of the pattern drawn, after which the mold was reassembled. These molds were provided with four heads and were poured through two gates. They were dried on the molding floor by an oil flame having an underground combustion chamber. The cores employed were three in number and involved nothing unusual. For pouring each stern post, 51,315 pounds of metal was required, while the weight of the finished casting was 42,000 pounds. Supplementing each stern post is a stern post cap or head which weighs 22,000 pounds. These castings were put up in a 14 x 14-foot flask having a 36-inch drag and 24-inch cope.

Figs. 6, 7, 8 and 9 portray the equipment and methods employed in producing the stern post for an 8800-ton merchant vessels built by the Merchant Shipbuilding Corp. at Harriman, Pa. This casting, shown in Fig. 3, weighs 36,600 pounds in the rough, before removing the gates and risers, and when ready to be shipped tips the beam at 27,000 pounds. Its average cross section is 7½ x 10 inches, although in some places it is heavier. Its overall height is 35 feet 2 inches, and its length is 10 feet 4 inches. It is put up in a 10 x 20-foot flask, the cope being 12 inches while the drag is 24 inches deep.

Inasmuch as the flask is not wide or long enough to contain the entire mold, it is provided with two extensions. These are rammed with the remainder of the mold but are not bolted to the main flask until after they have been passed through the drying oven. One of these extensions,

FIG. 7—FINISHED DRAG SECTION OF MERCHANT SHIP STERN POST MOLD SHOWING FLASK EXTENSIONS

3 x 8 feet, with a 12-inch cope and a 24-inch drag, completes the height of the stem while the other, 2½ x 5 feet, completes the length of the base. Owing to the thickness of that portion of the stern post which embodies the propeller hub, this portion of the mold is reinforced with additional sand, which is rammed in boxes, 8 inches deep. After drying, these are bolted to the cope and drag, respectively.

Only a few cores are employed in producing the stern post mold. They are simple, round cores for making holes in the pintle bosses and the propeller hub. The mold is extensively bracketed to prevent shrinkage cracks during contraction. The casting is poured through one gate. The risers are five in number, one being 20 inches and the others 16 inches in diameter. Three test pieces are cast in each mold. One of these molds is put up in four days by a crew of three molders and two helpers. In addition to the four days on the molding floor, the time required for producing a merchant vessel stern post casting is 1½ days for chipping, 48 hours for annealing and one to two days for loading on cars and shipping.

Twelve tons of facing sand and 24 tons of burned sand are employed per mold in producing these stern posts for merchant vessels, while 120 tons are required in making a battleship stern post mold. The preparation of the huge quantities of sand for the large numbers of molding floors at this plant is accomplished with the aid of mechanical sand mills. These mills, which were designed and constructed at the plant, are of the pan muller type. The pan is rotated by a motor driven pinion, and the rotary grinders are actuated by friction with the pan. Each mill has capacity for grinding and mixing about 50 tons of sand per day. The sand is taken to the molding floors in 2-ton buckets which are transported by a traveling crane. In addition to the large amount of sand, each of the merchant vessel stern post molds require about two tons of gaggers, six kegs of 20-penny nails and two kegs of 60-penny nails. The flask in which this casting is molded weighs 25,000 pounds. These molds are manipulated with the aid of a 50-ton electric traveling crane.

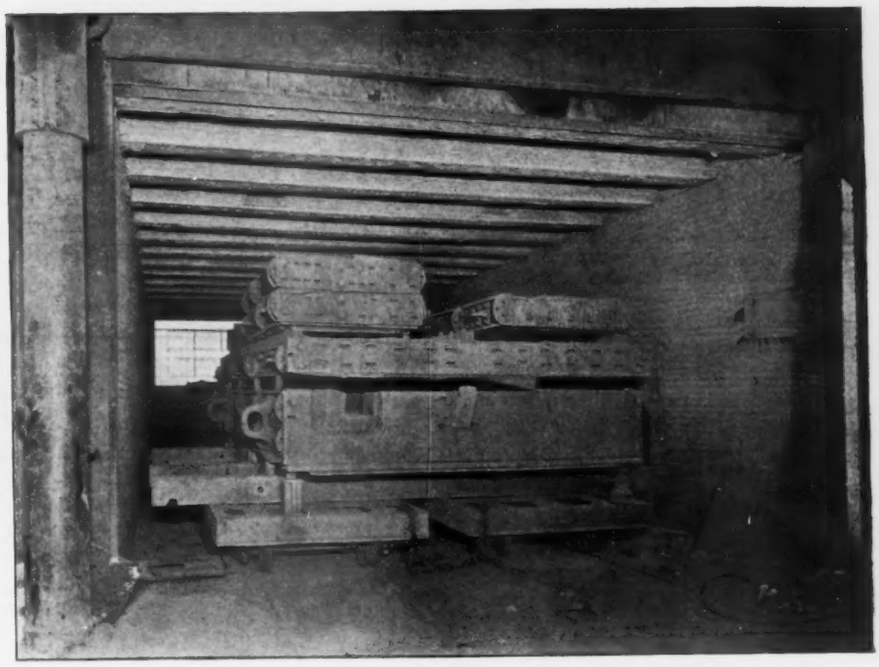


FIG. 9—TWO COMPLETE MERCHANT SHIP STERN POST MOLDS IN THE DRYING OVEN READY TO BE PLACED ON THE DRY FLOOR FOR FITTING AND POURING

For drying the merchant vessel stern post and other big molds, with the exception of those dried on the molding floor, the new casting shop is equipped with a number of large ovens of the car type. Of these, the largest is 18 1/3 x 62 feet, and 12 feet high. Castings for two complete molds may be dried in this oven at one time, as shown in Fig. 9. After drying, the cars are pushed out of the other end of the oven which opens on the dry floor. Here the molds are fitted up and poured.

The production of these castings, as of all others at this plant, progresses by straight line methods, which automatically keep the work constantly on the move toward the shipping point. At either end of the dry floor is a chipping shop, one for heavy and the other for light castings. Each is provided with annealing furnaces, scales and shipping points, thus keeping the use of labor, cranes, etc., at minimum. The stern post castings are handled in what is known as the No. 2 chipping shop. This shop is equipped with a number of large furnaces of the pit type, including one 11 x 43-feet and 5 feet deep. In this furnace, the stern posts are annealed. This furnace is oil burning, and has one burner at each end.

FIG. 8—COPE SECTION OF MERCHANT SHIP STERN POST MOLD SHOWING BOX FOR REINFORCING PORTION OF MOLD CONTAINING THE PROPELLER HUB

The Electric Furnace Construction Co., Philadelphia, has installed a second Greaves-Etchells electric furnace at the Ford Motor Co., Detroit. Other furnaces have been ordered for the plants of Woodward, Gatty, Saunt & Co., Ltd., Birmingham, England, and G. & J. Weir, Glasgow, Scotland.

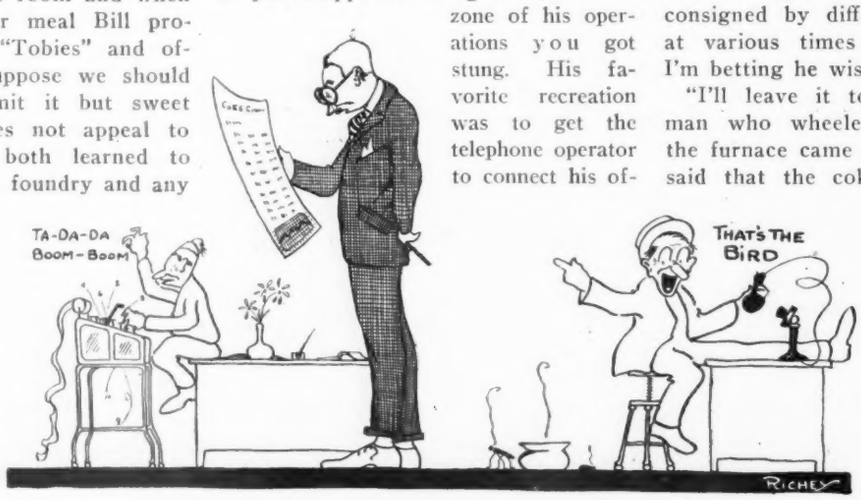
Bill Has a Word on Efficiency Edgar

By Pat Dwyer

BILL and I had lunch together the other day in a cafeteria—you know—one of those places where you grab things as you go along. First you select a tray and a handful of the necessary tools. Then you slide your tray along, picking up such articles of food on the way as you need, and finally emerge among the tables where you may select one if the crowd is not too large, and proceed to enjoy your food in peace. We were fortunate in securing an unoccupied table in one corner of the room and when we had finished our meal Bill produced a couple of "Tobies" and offered me one. I suppose we should be ashamed to admit it but sweet scented tobacco does not appeal to either of us. We both learned to smoke in a Canadian foundry and any person who knows "Montreal Twist" will at once appreciate our partiality for the brand of tobacco used in 3 for 10 stogies. I remarked to Bill how smoothly everything seemed to run in this restaurant and gave my opinion that it was owing to a well conceived and efficient system. Bill agreed that system was all very well in its place provided the gink (I use Bill's own term) in charge of it did not get hypnotized and try to make operation conform to system rather than make system conform to operation.

"I knew one of those systematic efficiency birds one time," said he, "who knew everything. In fact he knew so much that there was nothing left for anyone else to know. He was no shrinking violet by a mossy stone nor was he one of those rare, beautiful flowers that are born to blush unseen and waste their sweetness on the desert air—not he. I know of no flower with which to compare him in point of fragrance, but a piece of limburger cheese will do well for a substitute, for certainly whether he was visible or not, no one ever had a chance to forget that he was around.

"He was a natural born statistician and just loved figures. He had been brought up in a bank, and that may account for his expert knowledge of figures and how they may be used to confound the other fellow. And busy—you never saw anything so busy in your life except it may have been a squirrel in a wheel-cage. He was one of these live wires, meaning that if you happened to get within the zone of his operations you got stung. His favorite recreation was to get the telephone operator to connect his office with two departments at one time then he would lean back in his swivel chair and by alternately addressing one, and then the other, proceed to get them all tangled up in a knot by a series of irrevelent questions. If anyone asked him a question—just a plain, common, everyday question—he would answer it in that deeply cultivated tone affected by important men, and even more so by men who are not so important but wish to convey the impression that they are. He never used less than 100 words in answering any query and he could supply 500 or more without any trouble. Not satisfied with that, he would then dictate a letter to one of his stenographers covering the same ground more exhaustively and have it sent over by a special messenger.



HE WAS A NATURAL BORN STATISTICIAN AND JUST LOVED FIGURES

I forgot to inform you that he was chief clerk in the master mechanic's office and of course all the official clerical work of the different departments passed through his hands. He has long since passed to his reward; but like the colored preacher said when he was asked to say a few words over the remains of a certain useless and degenerate character: 'Oh, Lord, look with pity on the soul of this here niggah whut is now gone from our midst. We hopes he's gone where we 'spects he ain't.' If our efficient friend has gone to where he has been consigned by different shop foremen at various times during his career, I'm betting he wishes he was a camel.

"I'll leave it to you, suppose the man who wheeled in the coke for the furnace came to you one day and said that the coke shed was nearly empty and it would be a special mercy of Providence if he could scrape up enough to run the heat off that night. He had to have more the first thing in the morning or he would never be able to get his furnace ready in time. You'd give the fellow a bawling out for not reporting the thing sooner, then you'd go into your office and call up the master mechanic's office in order to get them to order a car of coke sent down from the coke ovens right away.

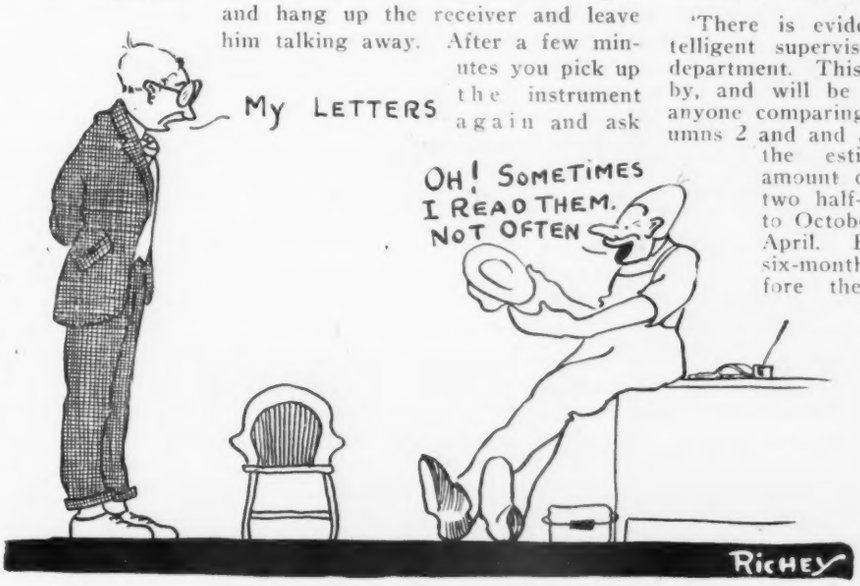
"The chief clerk never answered the phone himself, so you had to wait until he was through dictating some important correspondence. Of course if there was no immediate hurry, you would simply call the office and tell the clerk who answered the phone to put through a requisition for a car of coke. He would write out the order in quadruplicate, each copy on a different colored slip, and file them all away in one of the standard filing cabinets with which the walls of the office were lined. It was the duty of another clerk to shuffle

these orders over once a day just as the sun was passing the meridian, and select those orders whose serial numbers most nearly approached the actual latitude and longitude of the master mechanic's office as determined by the latest geographical survey. Due allowance of course was made for a possible variation in the position of Greenwich, owing to the troubled condition of Europe, and also cognizance was taken of the fact that in these latitudes the difference between the magnetic north and the true or geographical north is quite apparent and must be reckoned with in any calculation which aspires to accuracy. Having attended to all these preliminaries and worked the thing out by a table of logarithms to at least four decimal places the clerk would lay the selected list before the chief. This gentleman would look it over and if there was a semicolon, a dash, a capital letter or a decimal point more or less than there should be, well, the unfortunate clerk would get his. He would be directed to watch the passing of the meridian the next day a little more closely and in the meantime to look up some standard works on astronomy and navigation.

"As I say, this was the usual procedure, but when you are in a hurry you insist on speaking to the chief himself in order to expedite matters. You tell him that you are right out of coke and ask him to get a car down from the coke ovens that night. Does he say: 'Sure I'll do that little thing?' He does not. He drawls out in that maddening tone: 'Hold the line a minute, please.' You hold the line and bye-and-bye you hear: 'Ah! I have been looking up your coke consumption for the past six months, and I find that your daily average for all purposes is 20,278 pounds. Now of course we do not keep a separate cost account of the coke used in drying molds and cores, but your cupola report sheets show that your daily consumption of coke for the cupola alone is 16,200 pounds. We may then safely assume that the balance was used either in the core ovens or in drying molds in the floor. I have looked up requisitions for the past six months and I find that we have ordered and received a grand total of 3,163,368 pounds. You will pardon me if I am in error, but my calculations seem to show that we should have enough coke on hand to melt 11,764 pounds of iron at our present indicated ratio of 8 to 1. You will thus see that your claim of having no coke is either unfounded and entirely ridiculous or else a quantity has been willfully wasted.'

DOES HE SAY: "SURE, I'LL DO THAT LITTLE THING?"

"You say to yourself, 'good night' and hang up the receiver and leave him talking away. After a few minutes you pick up the instrument again and ask central, who is a friend of yours, to try and locate the M. M. When you get him you tell him you must have coke for the next day. He probably says, 'Call up the office, Mr. Prim will attend to that.' You tell him you had tried that and all you could get out of Mr. Prim was statistics and bull, and as neither one will melt iron you have found it necessary to appeal the case to him. He is the boy to work for.



THAT OUTSIDE IRONWORKER WAS IMPERVIOUS

"After profanely expressing his opinion of things in general the M. M. calls the coke oven department and says: 'Frank, send us down a car of coke tonight, we are right out, the requisition will go in tonight's mail.' That would be all about it from the M. M., but not from the gander in the office. The next morning you get a letter from him saying: 'Mr. William Oldtimer, Foundry Foreman. Dear Sir: Confirming our conversation of this afternoon concerning daily consumption of coke, I would beg to submit the following figures for your consideration.' He then shows in tabulated form the amount of coke used per day, per week, per month and per year since the plant was built. The probable consumption for the next six months at (A) our present rate of melting; or (B) allowing for a 10 per cent increase in tonnage to meet contemplated enlargement of our scope of operations is set forth. He concludes by saying:

'There is evidently a lack of intelligent supervision in the foundry department. This is clearly indicated by, and will be readily apparent to anyone comparing, the figures in columns 2 and and 3 in which is shown the estimated and actual amount of coke used in the two half-yearly periods, May to October, and November to April. Each of these is a six-month period and therefore the same amount of coke should have been used in each. A glance at the subjoined table will show a marked discrepancy. I am also enclosing a chart which shows in graphic form the relative amount of coke used each month. You will note that the curve begins to rise in September and keeps rising steadily until January when it reaches its maximum. It then gradually goes down until in May it seems to have struck its level, for from then on it remains fairly constant. Another point which I wish to bring to your attention is that this abnormal use of coke took place during

(*Concluded on page* 478)

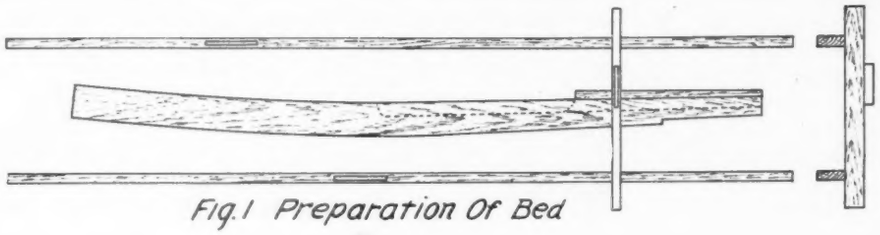


Fig. 1 Preparation Of Bed

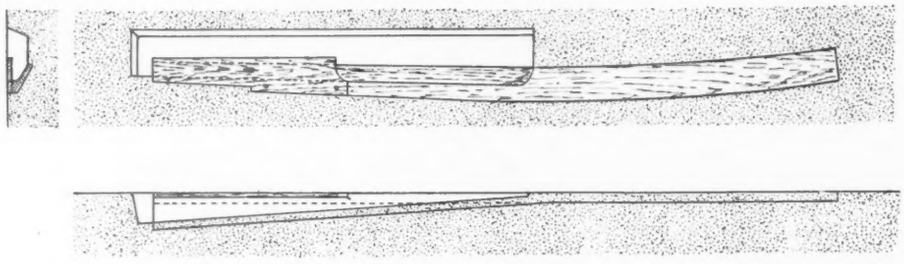


Fig. 2 Pattern Bedded In & Preparation For Drawback

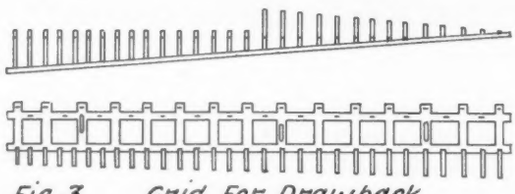


Fig. 3 Grid For Drawback

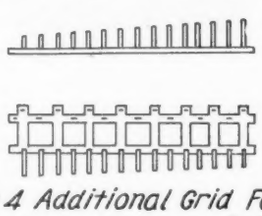
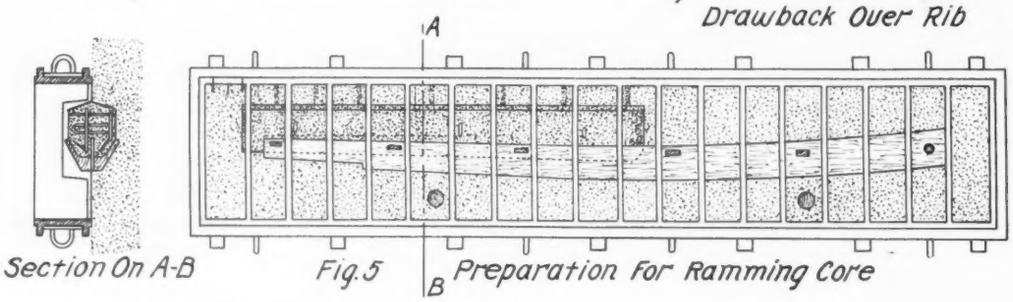
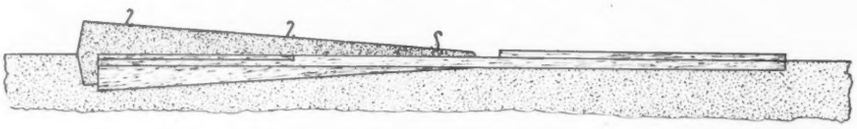


Fig 4 Additional Grid For Drawback Over Rib



Section On A-B Fig. 5 Preparation For Ramming Core



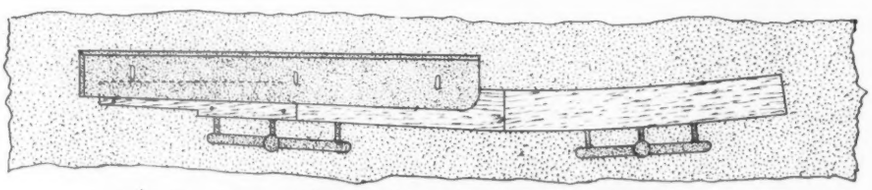


Fig. 6 Drawback Ready For Lifting

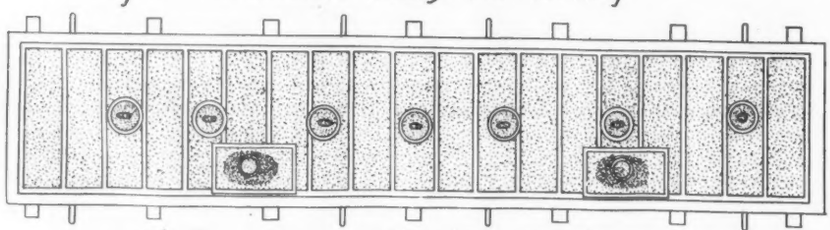


Fig. 7 Preparation For Casting

FIG. 1—PREPARING BED FOR STRAIGHT STEM PIECE. FIG. 2—PATTERN BEDDED IN AND PREPARATION MADE FOR THE DRAWBACK. FIG. 3—GRID FOR DRAWBACK. FIG. 4—ADDITIONAL GRID FOR DRAWBACK OVER RIB. FIG. 5—MOLD WITH COPE FLASK SET AND READY FOR RAMMING. FIG. 6—TWO VIEWS OF DRAWBACK READY FOR LIFTING. FIG. 7—ARRANGEMENT OF GATES AND RISERS

Castings for Ship Construction—VI

Difficulties Attendant Upon Molding and Casting the Three Common Types of Stem Pieces Are Described—Drawbacks Are Required and Special Flask Arrangement is Necessary for Awkward Shapes

BY BEN SHAW AND JAMES EDGAR

PREPARING molds for stem pieces provides one of the most straightforward jobs in connection with large steel castings for ship construction. This is largely accounted for by their simplicity of design, which reduces to a minimum the contraction difficulties. Although these stem-piece castings are less difficult to prepare and cast than some others, they are not as simple as may be imagined. Their strength and proportionately small sectional area, tapering off gradually in thickness toward one or both extremities, demands considerable care in running the metal. The difficulties will be surmounted if ample risers or feeder heads are used. It is not profitable to reduce the number of feeder heads to save the cost of cutting them off the castings, and run the risk of scrapping the casting. The cost of removing heads from the casting should be a matter of secondary importance. Increasing the number of risers assists occluded gases to escape, reduces resistance to the molten metal, and provides a body of metal at intervals from which the casting can draw metal during the time of solidification. These factors all increase the prospect of obtaining a sound casting. The representative types, while varying in their methods of preparation only to a minor extent, demonstrate the more common types of stem pieces required, and cover a variety of contours and sections.

The patterns for stem castings are unavoidably weak and require careful handling. Sometimes, in addition to being formed by two symmetrical jointed halves, they are made in two or more pieces for convenience of carriage by rail, and the molder is depended upon for assembling the different sections. In all such patterns where the sectional shape varies, it is best to joint them through the center, to assist the molder to obtain an impression straight and out of winding.

In dealing with all the varying types of stem pieces, the molder first prepares a straight bed, either for the roll-over or bedding-in process. The level bed is essential, owing to the fragile nature of the pattern. Fig. 1 shows the method for insuring the necessary condition of the bed. The straight edges in the bottom of the bed are frequently faced with hoop iron, as is also the sweep used for scraping-off the superfluous sand. The straightedges are bedded into the foundry floor, tested until their position is fixed, and the sand between them is then leveled. The accuracy of the casting depends upon the preparation of this bed. If the roll-over process is adopted, the bottom half of the pattern carrying the internal rib is laid upon the bed as shown in Fig. 1, the inside being fitted up and struck off to provide a print for the core. A dusting of parting sand is given the bed and improvised core, and the bottom box lowered over, preparatory to ramming. This method is advantageous because ramming the sand in this way is a comparatively simple operation, and a more regular density is secured as the mold is more accessible. By this method the molds may be removed for drying purposes or tilted for casting. However, difficulties are frequently encountered with regard to box parts of such large dimensions. The increased expense, and sometimes absence of system with box parts, renders it imperative for the bedding-in process to be adopted.

Molding Methods

In commencing this process it is better to mark the contour of the stem piece on the prepared bed, using the reverse half of the pattern to that which is going to be bedded-in. This provides a guide in cutting out the sand, and enables the molder to prepare for bedding the pattern in, without disturbing the bed more than necessary. Set in the bottom half of the pattern and obtain an approximate guide for the depth. Remove the pattern, and make the size of the hole large enough to take in the composite, which is to form the surface of the mold and come into contact with the pattern. Again lower in the pattern, and press down, until its joint surface coincides with the surface of the bed. Hammering directly on the pattern must be guarded against, as this is likely to alter its shape. It will be necessary to remove the pattern a few times to secure an equal density of sand.

Once it has been set to the satisfaction of the molder and a few pieces of metal laid upon it, the outside is rammed, the floor sand of the bed cut out, and a prepared facing is worked in against the pattern. The outside ramming tends to lift the pattern, so that it is wise to test the surface to see that it remains level with the bed. Any slight inaccuracy should be rectified, and the joint struck off.

Preparation may now be made for the core or drawback by cutting back the sand as shown in the sections of Fig. 2, allowing sufficient bearing beyond the pattern to take the balance of the weight of core to be formed. Considerable taper should be given to the sides where possible. Sometimes the pattern is formed to provide an impression similar to that shown, a corebox being supplied to give the necessary shape. The latter method is not recommended in a job of this kind. There are times when a great saving of time is secured by supplying coreboxes for large steel work, but the molder has a clearer conception of what is required when the pattern is similar to the casting wanted. In this instance, preparing a core in the mold is not a difficult task, nor does it retard the progress of the work of making the mold to an appreciable extent.

When dealing with irregular cores of this kind, preparing cores in the form of drawbacks in their correct position possesses advantages. The cores are then more likely to bear a closer relationship to the rest of the mold than would otherwise be the case. Having cut out the print as indicated in Fig. 2, dust it well with parting sand. Sometimes a coating of ordinary sea-sand is sleeked over the tapered sides, leading to the joint, and a good lift is insured. The rib should be removed during the process. A grid is required to take the shape of the core, and since the shape varies, it is a good plan to cast in wrought-iron pieces along the inside, so that they can be bent conveniently to suit the shape of the core. The grid is made in two pieces, the customary method being shown

in Figs. 3 and 4. The bottom grid is fitted in position and the prod adjusted to requirements, preparatory to making a start with the drawbacks. It is advisable to use a more plastic form of composite in this case to avoid ramming, and a good layer should be applied about the bottom to receive the grid, which should be clay washed and bedded in. More composite then is applied and gradually worked up to provide a bed for the rib, which can be screwed into position on the pattern. The top half of the pattern can be laid in position, and the shape of the top grid adjusted. The top of the rib is then covered with composite and the grid bedded in, securing it to the bottom grid so that the rigidity of the drawback as a whole is insured.

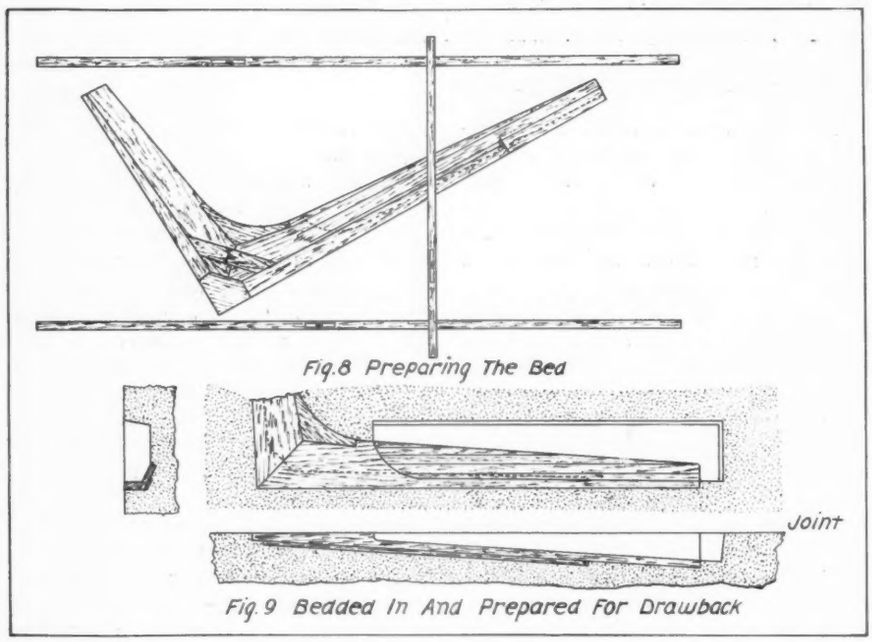


FIG. 8—PREPARING THE BED FOR A RIGHT-ANGLE STEM PIECE MOLD. FIG. 9—PATTERN BEDDED IN AND PREPARED FOR THE DRAWBACK

Other Drawbacks

Sometimes these drawbacks are built up with bricks upon a plate. With the former method, however, the center of the core can be filled with cinders and connections made with the joint of the mold as shown in Fig. 5, so that gases and increased volume of air due to the high casting temperature will escape easily. Composite is worked in along the top half of the pattern to form a dense contact, care being exercised to preserve the shape of the pattern, as it is weak and liable to become misshapen with the pressure applied, or raised from the joint. A sufficient covering of this composite should form a surface of the drawback to insure strength. It is formed as shown in Fig. 6, with a taper along the sides to prevent injury when lifting the cover flask. When this is accomplished the top half of the pattern may be removed temporarily, and the drawback made up. Hot bricks are applied to stiffen the surface of the core, to allow the work of covering to proceed more readily, and with less danger to the drawback. The sand surrounding the tops of the staples in the grid is cleared and the whole is covered with pieces of sheet iron to prevent damage. The cope flask may be set into its position as soon as the drawback is sufficiently skin dried, and the pattern returned to its place. The flask may be solid and in one piece as shown in Fig. 5, two or more flasks may be used, or instead of either of these methods a frame box with loose bars bolted in would suit admirably. Whichever method is adopted the flask must be well staked to insure the relative position being retained when lifted and returned. The drawback should be dusted with parting sand, gatesticks set and the headers laid in position, fixing them with composite, as shown in Fig. 5 before the cope is rammed. A good supply of gaggers is required to support the sand in the top to the joint. These should be clay washed and suspended from the top bars and against the sides. A layer of composite is then applied, followed by ordinary floor sand until the entire cope is rammed and leveled.

Lifting the Cope

This accomplished the gatesticks and risers are withdrawn, and the cope is lifted and rolled over. If the flask is in one piece or can be fastened together as one piece the top half of the pattern may be lifted with it, provided screw eyes are inserted into the pattern from the top, and secured to hold the patterns while being turned over. The sand is then compressed about the joints, and the runners prepared as shown in Fig. 6. No special attention should be given

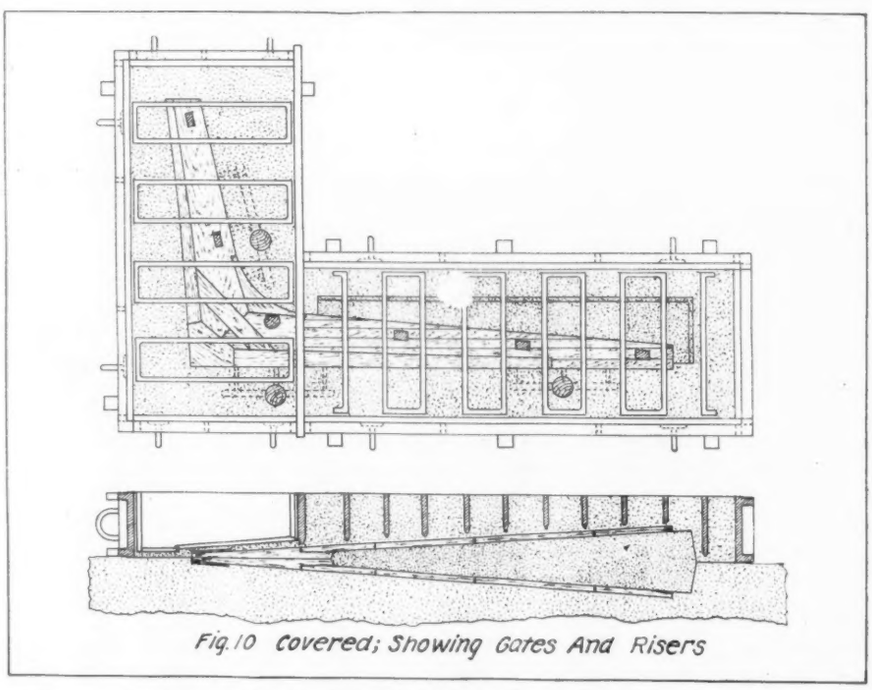


FIG. 10—COMPLETED MOLD FOR THE RIGHT-ANGLE STEM PIECE COMPLETED AND COVERED—NOTE THE GATES AND RISERS

to the runners, with regard to the quality and refractory nature of the lining used.

With the cope removed, the screws holding the rib are loosened, the drawback lifted to release the bottom portion of the pattern. With both sections of the pattern withdrawn the mold is sleeked. During this process plenty of brads are worked in to strengthen the surface, especially at the square corner formed to take the ship's plates. This corner should be maintained as sharp as possible in the casting and for this reason the sand should be well supported. Next, it is necessary to clear away or strengthen any impediment to the inrush of metal in both cope and drag, stamp a number of dabbers along the bottom, and set the cope on standards over the drag ready for closing. The sides can be practically sealed and the mold dried in place. The core or drawback can be set upon a bogey and transferred to a drying oven, or if too unwieldy and thus difficult to handle it can be dried with the rest of the mold. This is usually arranged so that the drying process proceeds overnight in order that the work is not delayed. When thoroughly dry and while still warm, apply a coating of blacking to both mold and drawback, carefully sleeking and filling in any fissures which may have been caused while drying.

Final Preparations

After the satisfactory application of this blacking, the whole is again dried. In the meantime preparation is made for casting by securing tackle for gateheads and riserheads, and making them up with composite to the required shape. The mold being thoroughly dry, the drawback is set in and the mold closed. The gates are tried with chalk and lifted to see that all is clear, and finally lowered again. The prepared pouring basin and riserheads are then set as shown in Fig. 7. These are grouted with composite and the cope is weighted preparatory to casting. Two ladles suffice to supply the necessary metal.

The method of preparing the mold for the stem piece shown in Fig. 8 is similar. The bed with the pattern set is shown in this illustration. The bedding-in process is used in this instance also. Fig. 9 shows the pattern made up to the joint, and the sand cut away for the drawback. This stem piece lends itself more readily to a solid pattern and separate corebox, because the internal shape is more regular. The core can be made in the form of a drawback equally as easily as in the former instance, and it is the method usually preferred. After making the core, setting in a grid, and forming the joint as previously mentioned, the gatesticks and risers are set and the cope flask placed. Two pieces usually are employed as indicated in Fig. 10. These two parts can be secured together and lifted as one box, or by separating them and using special bars carrying prods, a joint may be made and each flask lifted separately. Care must be taken, however, to insure a correct return to positions when replaced for casting. The gates, three being sufficient, are shown in Fig. 10 together with the headers.

The stem piece shown in Fig. 11 is much larger and more awkward

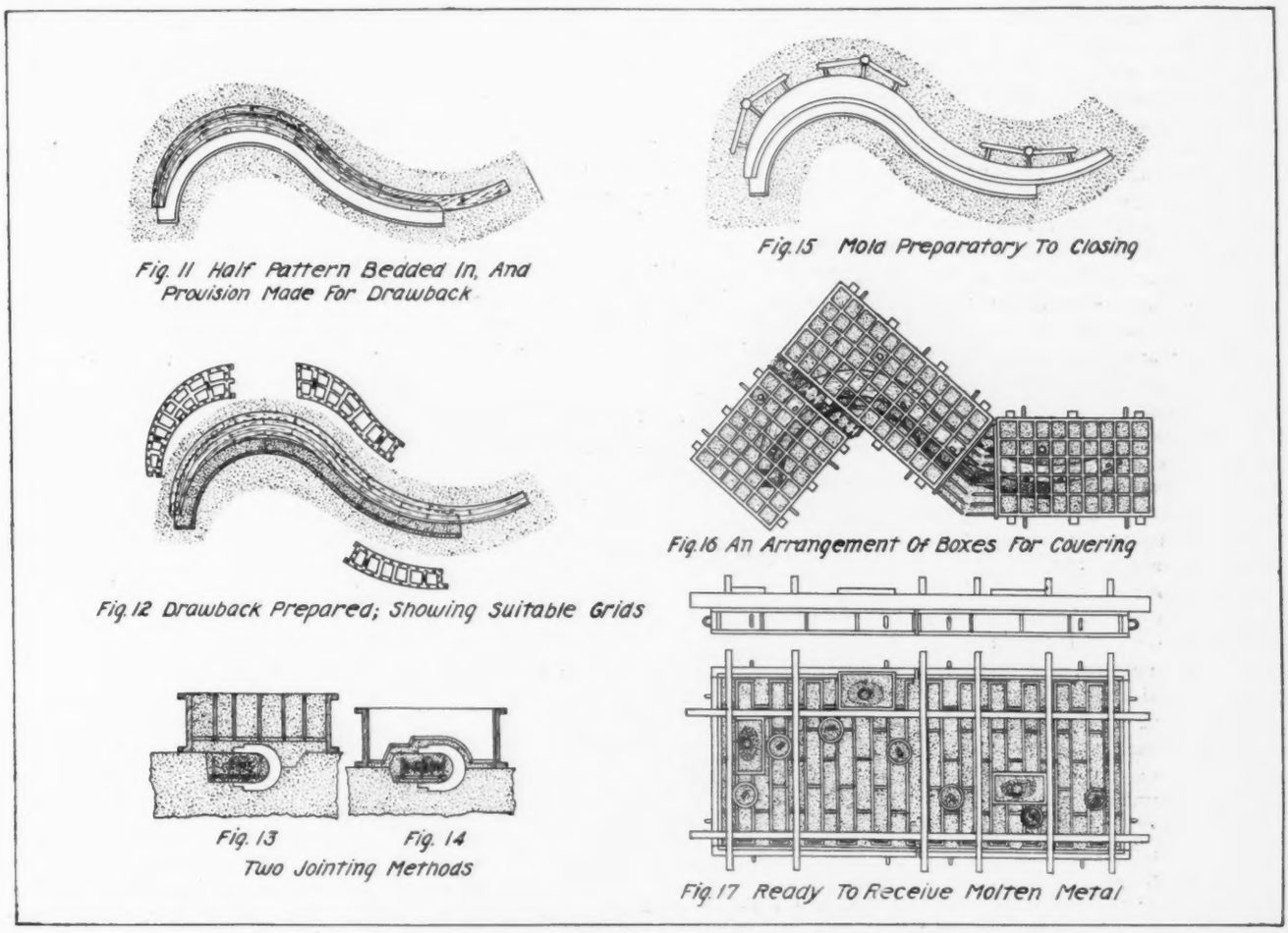


Fig. 11 Half Pattern Bedded In, And Provision Made For Drawback
Fig. 12 Drawback Prepared; Showing Suitable Grids
Fig. 13
Fig. 14
Two Jointing Methods
Fig. 15 Mold Preparatory To Closing
Fig. 16 An Arrangement Of Boxes For Covering
Fig. 17 Ready To Receive Molten Metal

FIG. 11—HALF PATTERN FOR THE RAM-NOSED STEM PIECE BEDDED IN AND PREPARED FOR THE DRAWBACK. FIG. 12—GRIDS USED FOR THE DRAWBACK ON THIS STEM PIECE. FIGS. 13 AND 14—TWO METHODS FOR JOINTING THE MOLD OF A RAW-NOSED STEM PIECE. FIG. 15—MOLD COMPLETED AND READY FOR CLOSING. FIG. 16—ARRANGEMENT OF COPE FLASKS FOR THE RAM-NOSED STEM PIECE MOLD. FIG. 17—MOLD READY FOR THE METAL

to cast, and is invariably bedded into the foundry floor, because of the size. The prepared bed is equally as essential as in the former instances, the top half of the pattern being laid on to obtain the contour for cutting out. In this instance the drawback, if made whole, would be awkward and unwieldy. Therefore, for convenience, it is separated into three pieces. Fig. 12 shows the pattern bedded in and the sand out away to form a drawback, together with suitable grids for dividing it into three portions. In these grids it is an advantage to cast in pieces of wrought-iron for convenience in taking the shape of the inside of the stem piece. The jointing of the piece may follow the surface of the drawback as shown in Fig. 13, and drop down to coincide with the center of the pattern, raising or lowering toward the joint of the box part to provide a level bearing. This method reduces the amount of top lift, and allows for the use of a number of solid flasks having bars cast in. In this instance the cope if made in one flask or a number forming one unit would be expensive as regards tackle, and would tax crane equipment that would otherwise be capable of dealing with work of this character.

A method of using a number of solid flasks is shown in Fig. 16. Grids are firmly secured to them at the places where joints are necessary. In this way each piece can be fitted separately, and it is a convenient means of using stock flasks. When it is desirable to make the joint of the mold coincide with the joint of the pattern, a greater part of the mold will be carried in the cope and more care is necessary in the selection of the flask to carry it. The joint may be made as indicated in Fig. 15, resembling the methods described previously. A framed-up flask having loose bars will meet requirements, providing stocks will meet the demand, and it may be possible to secure them in sizes, capable of making two parts large enough for the job as shown in Fig. 17. Loose double bars for large flasks require stiffeners cast with them, and when bolted in the flask a number of wood bars are fixed between them to assist in supporting the sand.

Both methods for forming a cope for such a stem piece are used, but in each instance every care must be exercised to provide a good support for the sand, where the flasks join each other, by casting short bars on the last bars of each part, and at right angles to them as shown in Fig. 17. When this method cannot be adopted conveniently as in the case when solid flasks are used, grids should be carefully secured as shown in Fig. 16. The methods of jointing shown in Figs. 14 and 15 are both adopted. When the former style is preferred, a flat bearing should be carried off the center, before being beveled up to the level suitable for the cope flask, as shown in the illustration.

In preparing the runners for a large casting of this type, a good supply of metal is required, and yet the number of gates should be as few as possible. The methods of running shown in Fig. 17 is one frequently adopted and is preferable to the single gate system sometimes used, supplying a long runner with a series of connections with the mold. Long runners are often the cause of contraction difficulties, and cause unnecessary strain in a casting. The arrangement for casting this job are shown in Fig. 17, three ladles being used to supply the metal.

The weighting of the cope requires special attention. A safe rule, which serves as a useful guide, is to multiply the lifting area, that is, the area of the cope with which the metal is to come into contact with the height of head on the gates, and then by the weight of a cubic inch of steel. Allow a margin for safety, including the weight of the cope itself, bearing in mind that it is better to have too much margin than too little, to allow for the momentum of metal entering the mold.

Bill Has a Word on Efficiency Edgar

(*Concluded from page 373*)

the very months when transportation was most difficult and every effort should have been made to economize as much as possible.'

" 'As this office has pointed out to you before (see form j.6 of April 7, '12, and same form of May 3, '13) it is of the utmost importance that our records of monthly operations be kept absolutely accurate. Therefore this office would be pleased to have you furnish a report at your earliest convenience explaining this apparent discrepancy. When this has been done we will be pleased to consider your request for a car of coke. In the meantime and in order to expedite matters the requisition has been made out and is now filed in folio 8-A-6, series 4. This office cannot impress upon you too strongly the importance of promptness in dealing with matters affecting the operation of your department. You will readily perceive that any delay or tardiness on your part in forwarding the desired information will have the effect of retarding the possible time of arrival of the car of coke. We have made a note of the time the request was received at this office and shall also note when the car is delivered. All delay of course is to be charged to the foundry department under heading, 'laxity in attending to official correspondence.' Trusting that you will give this matter your earnest consideration and hoping to have your hearty co-operation, I beg to remain,

Yours cordially,
Tom Brown, Master Mechanic,
Per E. Prim.'

"It was aggravating all right, but the M. M. was a real fellow and as Mr. Prim only had imaginary authority no one paid much attention to him.

"The nature of the answers sent to effusions of this kind depended a good deal on the personality of the men who received them. The machine shop foreman would scratch his red head, then grin and say to his clerk: 'Here, Jim, write this gink a letter and tell him that as far as I am personally concerned, I am not particularly interested in the political or financial administration of the republic of Peru but I shall be pleased to debate the matter with him any time with swords or pistols at 20 paces.'

"The pattern shop foreman kept them all in a special drawer in his desk and delighted to show them to visitors. Two or three of the letters he had framed and hung up on the wall.

"The boiler shop man would read them through, then get a 6-inch spike and a short, fat spanner and pin the letter up against the wall and what he said—well, I would not like to repeat.

"The old blacksmith would retire into his den and write four pages of careful explanation.

"I think, however, that the foreman on the outside iron work had them all trimmed. He called at the master mechanic's office one day on some business and our hero saw him.

" 'Ah! by the way, Mr. Steel,' said he, 'this office has sent you several communications during the past three months, but I do not recollect having received any reply to any of them. This is highly irregular and tends to keep our letter files in a more or less unsatisfactory condition. Might I inquire whether you received the communications I speak of, and if so what disposition you have made of them?'

" 'Oh!' said Angus, carelessly, 'sometimes I reads them and sometimes I just throws them away.' ".

The Industrial Electric Furnace Co., 53 West Jackson boulevard, Chicago, now owns all patents covering the Snyder Electric Furnace, F. T. Snyder having left the organization.

Cupola Metal for Bronze Castings

Heavy Work Can Be Poured from Cupola Metal if Proper Precautions Are Taken—Blast Must be so Regulated There is no Excess Oxygen —Methods Used in a Large Canadian Plant

BY CHARLES VICKERS

AS a brass melting medium, the cupola cannot be looked on with great favor, in spite of the fact that it is sometimes used with conspicuous success. These successes have been achieved in spite of the fact that all the conditions under which melting occurs in the cupola are opposed to those which experience has shown should prevail in the case of copper and its alloys.

Thus in cupola melting, the metal, the fuel, and the air blast, are brought into intimate contact, while every effort of the brass melter is exerted to insulate the metal from contact with the air and the fuel. The necessity for the isolation of the metal arises in the fact that nonferrous alloys high in copper have a strong chemical affinity for the sulphur always found in the fuel and for the oxygen contained in the air with the result that both are absorbed and ultimately react with the production of sulphur dioxide, a gas which is soluble in the metal both in the molten and the solid states and produces holes in the resulting castings. Iron is not affected in a similar manner because it is protected by its affinity for carbon, which it is able to absorb and retain, and it is the carbon that is attacked by the air and not the iron. In cupola melting as there always is an abundance of carbon available in the shape of fuel, there is no loss of this constituent but a slight increase, and the metal is effectually protected from the injurious effects of the oxygen of the air blast.

As copper does not absorb carbon it lacks the protection that would be afforded by this element if it existed in the copper; consequently, it must be protected by the carbon in the fuel, that is, the blast must be so regulated that there is no excess to be taken up by the copper, and the latter must be brought down quickly and tapped out of the cupola to get it away from contact with both fuel and air. When expertly handled the cupola will melt brass and produce excellent castings. During the past few years there have been numerous occasions on which it has been necessary to use the cupola for the production of large amounts of molten brass to pour castings beyond the capacity of the existing brass melting facilities.

This was the case with the Port Arthur Shipbuilding Co., Port Arthur, Canada, and the following interesting description of the plant of this concern, and the methods practiced in making large bronze castings from cupola melted metal was furnished by their foundry superintendent, Albert Congdon.

During the past three years, tail-shaft brasses for 25 ships were made at this plant from cupola melted metal, also a number of bronze pump barrels, and other large castings. The tail-shaft brasses were 4 feet, 6 inches long and weighed over 900 pounds each, and there were frequently three brasses to each shaft. Most of these brasses were cast on end, the metal entering at the top through two holes in the end of the flask. The runner was cut right around the core print like a girdle and from this runner gates were cut along the print into the casting as shown in Fig. 4. As many gates as possible should be cut in order to permit the metal to enter the mold all around the circumference of the core, thereby decreasing the danger of the metal cutting away the sand of the mold as it drops down. Some of the liners were also cast on an angle of about 45 degrees, with the metal entering at the bottom at both sides, and with a heavy riser at the extreme top of the mold. In casting bronze pump barrels weighing 575 pounds, castings that have to be perfect when turned, good results have been obtained by carrying the sprue down through the center of the core to the bottom of the mold and connecting to the casting by two channels in the bottom. Most of the metal for these castings was also melted in the cupola.

To make the molds, comparatively coarse sand was used, mixed in the proportion of two parts old molding sand and one part of new sand. The molds were well vented and thoroughly dried and were coated with a good grade of plumbago painted on.

For the cores no special mixture was used, but it was found that as a protective

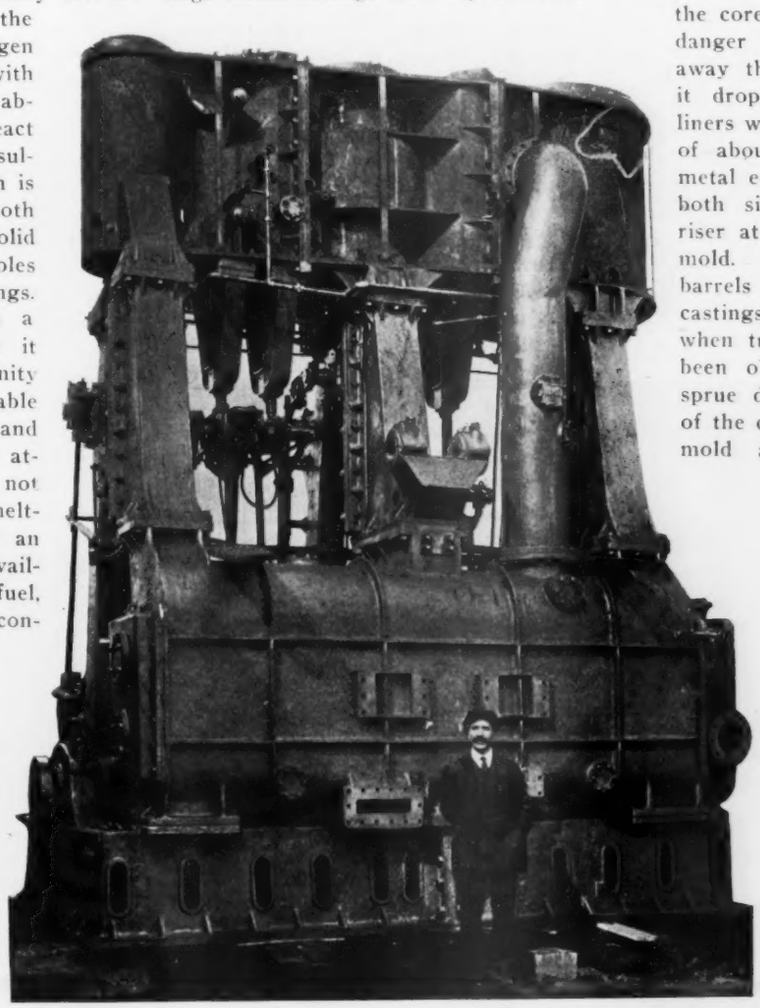


FIG. 1—A 1500-HORSEPOWER ENGINE SHOWING CHARACTER OF CASTINGS MADE AT PORT ARTHUR PLANT—ALBERT CONGDON, FOUNDRY SUPERINTENDENT, IS STANDING IN FRONT OF THE ENGINE

wash, silica flour gave the best results. This is the material largely used as a wash for molds and cores in making steel castings, and is a white, flour-like substance consisting of finely ground silica. It is mixed with molasses water and used like the ordinary plumbago washes. To melt the bronze a 30-inch cupola was used, and it was supplied, while melting was going on, with very little blast. About 400 pounds of coke was put on the bed. This is sufficient for one ton of bronze, and after the metal was all charged, a bag of charcoal was generally thrown in. Sometimes 25 pounds of heavy scrap brass was used in the mixture, in which case the copper was charged into the cupola 15 minutes before the scrap brass, in order to allow the ingots to get heated. After the brass was charged the blast was immediately put on, and in from 12 to 15 minutes the metal was down, and usually it came down hot. The tin and the zinc were melted in separate crucibles and were added to the copper after it had been tapped from the cupola into the ladle. Plenty of burning charcoal was always kept in the ladle, so the metal was covered and oxidation avoided. After the zinc and the tin had been added by pouring them into the copper, about 0.5 per cent of phosphor-tin was put in and the whole thoroughly stirred. The metal was then ready to pour into the molds.

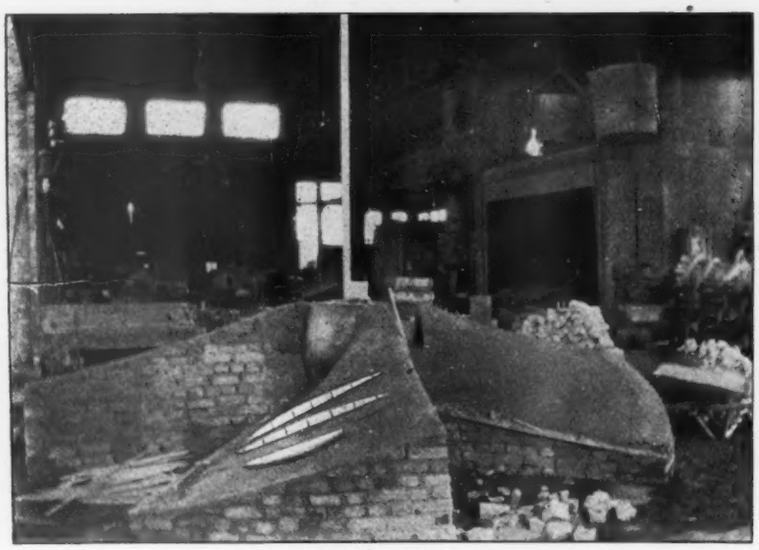
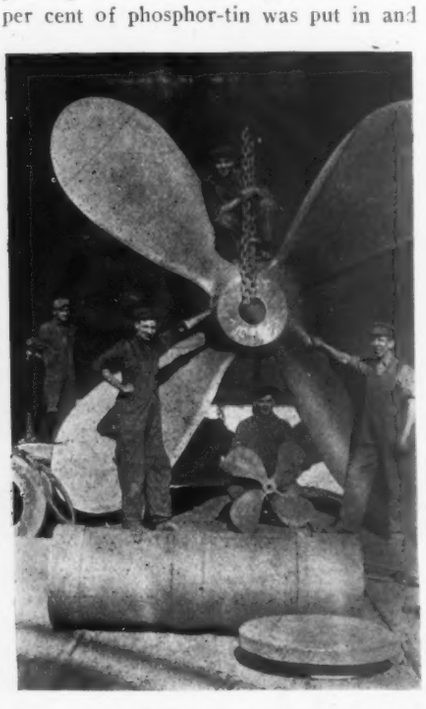


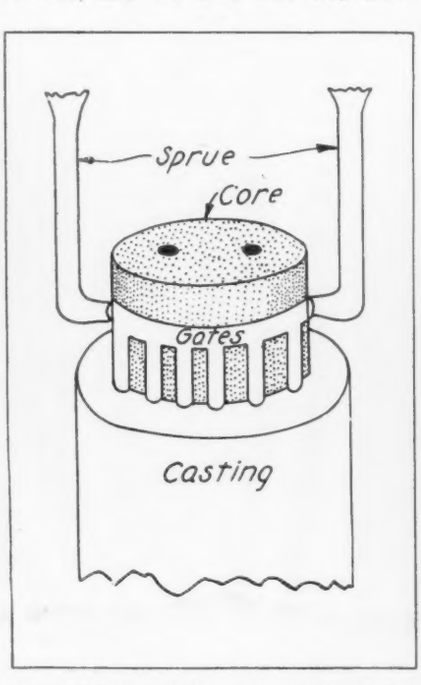
FIG. 2—MOLDING A 14-FOOT PROPELLER WITH A SWEEP

The outstanding features of the melting was the very small amount of blast used, and the rapid liquifying of the metal. The short time the copper was in contact with the fuel, 12 or 15 minutes, did not allow much opportunity for sulphur absorption, and the decreased blast precluded a strongly oxidizing atmosphere.

The Port Arthur Shipbuilding Co. operates the second largest plant of its kind in Canada and since 1913 has turned out a number of vessels of which the NORONIC, the flagship of the Northern Navigation Co., and the W. GRANT MORDEN, one of the largest freighters on the Great Lakes are notable examples. The foundry was completed in the fall of 1913, and the first heat was taken off Nov. 13, 1913. The first foundry building was 120 x 65 feet, of steel and glass construction, with steel charging floor and storage space, making it practically fireproof. In 1916 the shop was made 25 feet wider, giving more side floors and space for heavy work in the main building. In 1918 the foundry was again found too small and was lengthened by 40 feet, making the present foundry 160 x 90 feet. The shop is well ventilated and lighted, the windows in the peak, sides and ends being hinged and so adjusted they can easily be opened. The height inside is 60 feet to the peak. The main building is equipped with two 15-ton electric cranes, operating 30 feet clear of the floor which enables any flask to be lifted or rolled over without the extra effort incurred in digging holes in the floor. The oven equipment consists of three drying ovens comprising one drawer-type oven for small cores; one 8 x 8 x 16-foot oven with car for larger cores, and one 20 x 20 x 12-foot oven with double track and two heavy cast-iron cars for drying large molds and cores. This latter oven is fitted with a Kinnear rolling door and is sufficiently large to handle the largest cylinder molds made at this plant.

There are two Whiting cupolas, one a No. 3, and the other No. 6. The No.





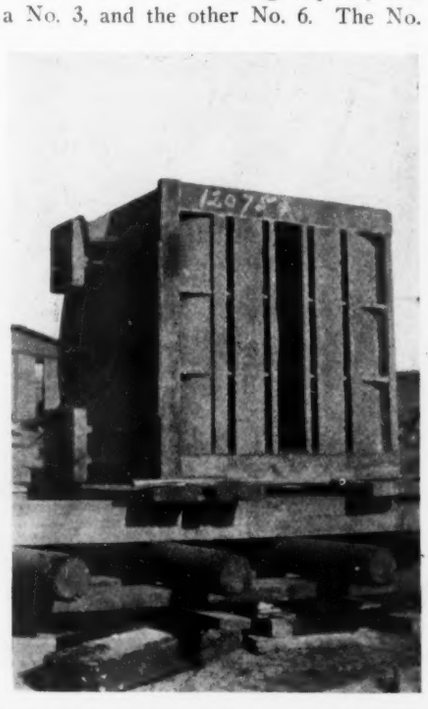


FIG. 3—A 14-FOOT 10-INCH PITCH PROPELLER IN THE CLEANING ROOM. FIG. 4—METHOD OF GATING LARGE BRASSES. FIG. 5—A 56-INCH LOW-PRESSURE CYLINDER CASTING

3 cupola will bring down four to five tons of iron per hour, and the No. 6 brings down about eight tons per hour. The cupolas are served by a Sturtevant blower driven by a 30-horsepower motor. The iron and coke is elevated 15 feet by means of an air hoist. An abundance of air for all purposes is supplied by the power house.

The brass foundry equipment consists of three coke-fired brass melting furnaces of 700 pounds capacity, and during the past year 60 tons of brass castings were turned out.

The castings are mostly for marine engines of the type shown in Fig. 1. These engines, weighing 70 tons, are lifted bodily aboard the boats by the aid of shear legs capable of lifting 150 tons. During the year 1918, 12 complete engines were turned out at this plant, all of which were fitted with triple expansion cylinders up to 56 inches in diameter, and the plans for the present year include a number of cylinders 63 inches in diameter. The loss up to date on cylinders has been only 3 per cent.

In addition to the engine castings, all the other castings required for the complete equipment of a vessel are produced in this foundry and propeller wheels weighing six tons each are being now turned out.

In ramming the molds, air rammers are extensively used; the sand is conditioned by sand mixing machines and gyratory riddles, and to prevent dampness from reaching the molds made in the floor, for such castings as engine beds, condensers and cylinders, two watertight steel tanks have been installed. One of these tanks is rectangular in form, 5 feet deep, 15 feet wide and 30 feet in length, and the other is cylindrical, 14 feet in diameter and 8 feet deep. The latter tank is used largely for cylinder molds.

The foundry floor space is about 10,000 square feet for molding purposes, the balance being taken up by the core ovens, core room, cupolas and cleaning room. During 1918 the plant of this company turned out 12 vessels, six trawlers, five freighters and one tug.

How and Why in Brass Founding

By Charles Vickers

Cast Aluminum for Use in Cooking Utensils

We are manufacturing aluminum cooking kettles using aluminum 99 per cent pure. We can purchase 99 per cent remelt aluminum ingots which we believe would be just as good for our purpose and about 2 or 3 cents per pound cheaper. The only question would be whether the zinc content of these ingots would be high enough to discolor the food cooked. It is our belief the material would be perfectly safe to use, but would like to get your opinion on the subject.

If the remelt aluminum is 99 per cent pure, and half of the missing 1 per cent is iron and silicon, there would only be 0.5 per cent zinc in the alloy, which is entirely too small to be noticeable. The iron and silicon probably comprise the greater part of the 1 per cent, and that doubtless, the zinc content would be much under 0.5 per cent, therefore, it is our opinion that this material would be just as satisfactory as the virgin ingot for the purpose outlined. However, it would be advisable to check the dealers analysis by having one of your own made before deciding to purchase any large amount of the remelted aluminum. Usually this class of material will contain around 2 per cent of zinc and some copper, in addition to the regular amount of iron and silicon. There is a possibility of course of making a good grade of remelted ingot by using sheet aluminum scrap of known analysis and exercising especial care to see that no foreign sheet finds its way into the melt, as all sheet aluminum is not 99 per cent pure. A considerable quantity of cast aluminum ware carries zinc, some of it consists of a large percentage of zinc, in which case the vessel itself discolors, but after using such a vessel for a number of years, no instance of food being discolored has come under the observation of the writer.

Remelting Aluminum

We accumulate a quantity of aluminum borings which we have been unable to remelt and must, therefore, sell at a considerable loss. We would like to know of a way to remelt the borings, or if they can be pressed into ingots, so we could again use them in our work.

Probably the most satisfactory manner of utilizing these turnings would be to have them briquetted, when they could be melted about as easily as solid stock. If it is preferred to melt them loose, however, this can be done by first melting a bath of solid aluminum, getting it about blood red then dissolving therein, all the turnings possible without causing it to solidify or become pasty. The furnace should then be closed again and after the molten aluminum has again become heated, more turnings may be dissolved and this operation can be repeated until the pot is filled with metal which may be poured into ingots. This is hot and tedious work, however, and has to be done skilfully or the loss is excessive.

Making Steel in Crucible Brass Furnaces

We are melting aluminum, bronze and brass for castings in gas fired pit furnaces with good success. We have decided to make small crucible steel castings as we can get a large amount of steel plate punchings about ¾-inch thick. We would like to know what proportion of ferrosilicon and ferromanganese should be used to get the best results. Also is it necessary to use silica sand and to dry the molds? Should a flux be used in melting the metal? Is it necessary to anneal the castings? What is the cause of blow holes in steel castings?

The first consideration will be to obtain the crucibles. Get the regulation steel melting crucibles, and do not attempt to use brass melting crucibles. It will also be prudent to use silica sand, and the whiter in color it is the better for the purpose. Use it for facing, and to give it body mix it with good fireclay. Large numbers of steel castings now are made in green sand, but as a starter it would be wise to skin dry the molds before pouring, then as experience is gained they can be poured green. Add molasses to the sand for many different mixtures for crucible steel castings. If it is preferred to pour green, avoid dropping water on mold surfaces as is the custom in molding for nonferrous metals, and for cast iron. Steel will not lie to the wet spots and a little explosion may result when molten metal strikes these spots. It may

not be necessary to anneal all castings; but sometimes customers are strongly prejudiced in favor of this proceeding. In melting steel in a crucible, use no flux as there is always a slag produced in melting. Some use salt and charcoal but this is not necessary. The charcoal adds carbon but it is difficult to say just what the salt may do. There are many different mixtures for crucible steel made by melting various proportions of punchings, muck bar, washed metal, file scrap, horse nail scrap, and so forth. When punchings are melted alone about 8 ounces of ferromanganese and 8 ounces of ferrosilicon can be added, with a little metallic aluminum immediately before pouring. The blow holes are due to gases generated in the steel by reactions between carbon and oxygen, and sulphur and oxygen, and if the metal is poured after being simply melted, the heads will swell up like a cauliflower and the castings will become porous. Silicon and manganese act as deoxidizers, and the less that is used the softer the metal will be, if low carbon material is melted. Aluminum efficiently prevents blow holes, and there are few steel castings made that are not treated with aluminum as the metal falls from the ladle to the runner head. Add the ferroalloys to the steel, by means of an iron pipe introduced into the hole cut in the crucible cover. Have a long pipe with a clean bore to give velocity to the alloys so they will be carried underneath the slag blanket, otherwise they may remain in the slag and the castings will be spongy. The pouring is important, and must be done quickly, otherwise the steel will set in the crucible. A small electric furnace would probably be more convenient for your purposes than would crucibles.

Using Scrap Brass in Alloys

We operate an iron foundry but have decided to cast a number of light bearings. In this connection we note the brass foundries in this vicinity are using old scrap brass for such work. We presume some new metal is added, but not being well informed on this subject we would like to get from you a few pointers in regard to mixing brass and making up alloys from old metals, as we do not remember to have read advice on this subject in your columns as all the mixtures appear to treat of new alloys.

As the composition of scrap brass or bronze will vary with every piece in the scrap pile, it would mean nothing to give mixtures for various alloys in terms of scrap brass. The proportions of copper, tin, lead and zinc comprising any particular mixture are given in percentages to form a guide as to the kind of an alloy most suited to the particular case. When scrap brass of known composition is available this can be worked in to produce an alloy of the analysis suggested in exactly the same manner as in the case of cast iron which now is most generally mixed by analysis. For many purposes only alloys of known composition can be used, and in such cases scrap metals can only be used when their analysis is determined. Generally speaking this is the case with all high grade alloys that are expected to conform to specifications covering physical properties and chemical composition. Immense quantities of brass castings are made in which chemical composition and high physical properties are of less importance than soundness and general appearance of the castings.

However, in this latter case the utilization of scrap will depend entirely upon whether its use injuriously affects the appearance of the castings and their freedom from defects. This will depend entirely upon the character of the scrap metal available. It frequently happens that the percentage of loss in castings, incident to the use of scrap, runs up the cost of the castings to a point much higher than would be the case if new metals were used. Many brass founders realize this and use new metals, or ingot metals purchased from producers who sell on analysis, and are known to be reliable, even when the composition of their castings is relatively unimportant. If a fair grade of red composition scrap can be obtained, it could be used entirely in the light bearings mentioned. No admixture of new metals is necessary. Scrap cocks and faucets would be cheaper than red composition, but they do produce the same clean castings. It would not be advisable to attempt to use yellow scrap, unless it was handled by those familiar with its peculiarities, because the percentage of bad castings would soon run the cost above that of all new metal. Less difficulty would be experienced if an alloy of the following formula were used: Copper, 83 per cent; lead, 10 per cent; zinc, 5 per cent and tin, 2 per cent.

In making this new mixture scrap metals could be used. The copper could be crucibled heavy copper; meaning copper put into shape that enables it to be introduced into the crucible without cutting or bundling. Scrap trolley wire, cut into 14-inch lengths would be satisfactory. Scrap lead pipe could be used to introduce the latter metal, and block tin pipe or Britannia metal would reduce the cost of the tin. Also with this mixture about ⅓ scrap brass could be used. To make the alloy, first melt the copper and the scrap brass together, add pieces of hard wood and a flux composed of sharp sand, 2 pounds; lime, 2 pounds, and borax, ¼ pound. Use about 1 per cent of the flux. After the copper and brass is melted, add the tin, then the zinc and finally the lead. Stir the bath thoroughly. If any difficulty is experienced from porosity, place 0.25 per cent of 15 per cent phosphor copper in the bottom of the crucible before the copper and brass is charged.

If all scrap brass is preferred, place a little phosphor copper in the bottom of the crucible and melt using charcoal or hardwood and the flux as before described.

As an example of the use of scrap in mixtures the composition of which must conform to specifications, we will suppose that scrap yellow brass is available in the form of clippings of sheet metal. This can be assumed to contain about 70 per cent of copper to 30 per cent zinc. The mixture then would be as follows: Copper, 71 per cent; yellow scrap, 17 per cent; lead pipe, 10 per cent; tin or Britannia metal, 2 per cent. In melting this mixture charge the copper and melt alone, then add the yellow scrap and afterwards the white metals.

High-Lead Copper Alloys

We have an inquiry for a metal containing 35 per cent of copper and 65 per cent of lead. We would like to know the best way of making the mixture so that the copper and the lead will amalgamate, and the lead will not sweat-out of the mixture and sink to the bottom.

In some form or other sulphur is the element most generally used in copper-lead mixtures to hold the lead in solution. Some makers have good success with roll sulphur, others get along better when a sulphide or a sulphate is used instead of the roll sulphur.

Lead sulphide or galena has been successfully used by some foundrymen. It is added to the copper. Sulphates, such as plaster of paris also are used successfully. The plaster should be mixed with a little borax and soda ash. About 2 per cent is used, 1 per cent with the cold copper and 1 per cent after the lead has been alloyed. There are many other ways of making these alloys and some makers claim to be able to produce a very homogenous mixture. Magnesium lately has been coming into use for holding the lead in solution, but we are unable to state just how successfully this metal has been for this purpose.

How Slag Influences Electric Steel

Removal of First Slag and Making of a Second Not Considered Necessary — Highly Deoxidized Metal Gives Trouble When Poured Into Green Sand Molds—Superiority of Acid Steel Questioned

BY J. L. DIXON

THE increase of steel production resulting from the recent war, was accompanied by a more than proportionate increase in electric furnace installations. Naturally this increase in the number of furnaces has caused a much greater diffusion of knowledge of the art of producing steel by electrothermic methods, but it is doubtful if this greater diffusion of knowledge has been accompanied by a proportionate increase in the number of metallurgists who are aware of the finer points of the art. Still further, it is probable that the increase in the number of operators or melters has been accompanied by a decrease in the average degree of skill and also by a decrease in what is closely allied to skill, namely, watchfulness or carefulness. The writer has observed, both in the United States and abroad, that the more experienced and skillful the melter, the more interest he takes in his work, carefully "nursing" each individual heat like an only child. This applies not only to electric melting, but to steel melting of all kinds.

It may seem strange, but it is nevertheless true, that electric steel melting is now less standardized than it was a few years ago. This is due to the fact that until recently, electric furnaces were engaged entirely in producing steels of crucible tool-steel quality and the recent expansion into the lower-grade fields has led to much confusion. Some furnacemen have rigidly adhered to the old super-excellent quality of product; others have aimed at quantity output, abandoning all idea of producing steel superior to the product of other processes. A few have been able to steer the middle course and while obtaining a large output, have also secured a high-grade metal.

Refining Steel for Castings

Perhaps the most important field for the electric furnace, is in the making of steel castings. A thorough discussion of this application involves many complications arising from the fact that melting and refining in the electric furnace must be modified according to the class of work to be produced and the manner of making up the molds in the foundry.

Many steel foundries have found that the process of refining which is used in producing ingot steel of crucible quality, that is, finishing with a completely deoxidized slag, is not at all suitable for the general run of castings made in green-sand molds. Steel made in this way will sometimes yield unsound castings in spite of its obvious complete deoxidation. The author is unaware that there has been a final explanation of this, although several theories along the following lines have been advanced. One explanation is that even when run from a bottom-pour ladle, the steel will contain particles of slag. This slag contains carbide which at once reacts with the green sand liberating gases. Another explanation is that liberation of gases is due not to mechanically entrapped particles of slag, but to some substance, similar to calcium carbide, actually dissolved in the steel at the time of pouring.

Whatever the explanation, the fact remains that many steel foundries have given up the carbide or white-slag process, except when the specifications call for an extremely low-sulphur steel. When for any reason the white-slag process has to be used, dry-sand or some equivalent form of molding is used. If sulphur below 0.03 per cent is required, a completely deoxidized slag is necessary.

Melting Without Deoxidizing

When no attempt is made to deoxidize the steel, the process is almost similar to basic open-hearth practice except, of course, that very little or no pig iron is used. The charge is melted at about 0.30 per cent carbon and then rapidly heated to pouring temperature, at which time the carbon will be about 0.25 per cent. The alloys are then added and the heat poured, the slag at the time of pouring being black and containing large amounts of oxide. Steel made in this manner is probably superior to converter steel. In many cases the chemical composition of the metal is not improved by the process.

To avoid the difficulties resulting from the carbide-slag process and at the same time to insure that the product shall be of superior quality, the author has found that the following is good practice for foundry work.

In a 3-ton furnace the original charge should consist of approximately 6000 pounds of scrap with a piece of old electrode weighing about 20 pounds. If old electrode is not available, about 300 pounds of bessemer pig should be substituted so as to cause the bath to melt at from 0.25 to 0.35 per cent carbon. With the original charge should also be included 350 pounds of limestone, taking care to place the stone so that it will not insulate any of the electrodes. During the early stages of the melting about 100 pounds of lime (not limestone) is thrown under the electrodes to steady the electrical load. If an energy input of 900 kilowattes is maintained the charge will be melted in about 1 hour and 20 minutes and, if correctly proportioned, will contain not less than 0.25 per cent carbon.

Arc Buried in Slag

Even if castings of very low carbon are required, the melt-down should not show less than 0.25 per cent carbon. Immediately after melting a fracture test should be taken and if the carbon is too high, which is much better than being too low, the bath is allowed to boil using ore or mill scale additions if necessary. If the bath is boiling at all vigorously, a sample must be taken frequently and as soon as the carbon is at the point desired in the finished castings, two big shovels of petroleum coke are added. If the slag is in proper condition, this will cause a frothing, which is desirable for two reasons, one being that the frothing shows that the coke is doing its work of attacking the oxides, the other being that the arcs are thereby buried and the overheating of the walls and roof is prevented. With a little skill and judgment it is possible to bury the arcs entirely so that just before pouring a heat of extremely hot metal for light castings, it is almost possible to make the necessary observations without the aid of darkened glasses.

If the heat is for reasonably heavy castings, poured from a bottom-pour

ladle, it should be ready for pouring 15 minutes after melting, a small addition of spar being generally necessary to give the slag the degree of fluidity required for the rapid decomposition of the oxides. If on the other hand, extremely hot metal is required, then it will be necessary to continue the heating 30 minutes after the completion of the melting. In this case it will generally be necessary to make lime additions to keep the slag foaming.

Judicious additions of coke should be continued until the slag is of the color of a mild cigar, showing that the slag is largely but not entirely free from oxides. The last additions of coke should be allowed to work for a few minutes longer by which time the slag will be a shade paler, and then the heat is ready for the alloy additions. With the alloy additions it may be advisable to add a small amount of spar to insure that all the slag runs from the furnace.

The alloy additions for a 6000-pound heat consist of 40 pounds of 50 per cent ferrosilicon and 15 pounds of 80 per cent ferromanganese. These give a metal containing about 0.28 per cent silicon, and manganese equal to the content of the original scrap, say 0.60 per cent. The heat is poured about one minute after the addition of the alloys, a sample being taken a few seconds before tilting the furnace to verify the quietness of the metal. The taking of this last sample should never be omitted in any kind of electric steel melting. Instruction in this regard may seem superfluous, but this final sampling is often omitted, which is wrong, in spite of the apparently contradictory statement that at this stage the melter should have knowledge of the conditions of the bath as to make further sampling unnecessary.

Such metal is suitable for greensand or any other kind of molds. The wear and tear on the furnace walls and roof is small. There is also the obvious saving in time, labor and electrical energy resulting from not pulling off the preliminary slag.

Recently many electric steel foundries have operated their electric furnaces with acid linings. This process has many advantages, among which may be noted smaller maintenance costs for furnace linings due partly to longer life of roof and walls, and partly to the cheaper materials used for hearth construction. The longer life of the walls and roof is largely due to the absence of lime vapors, which are present in the basic furnace. Another advantage is that the acid slag deoxidizes the metal almost automatically, owing to strong affinity of acid materials for iron oxide which, of course, is basic. This results in the process being quicker and requiring less skill and attention. Another advantage is that, for a given energy input, hotter and more fluid metal is produced by the acid than by the basic process. This apparently higher temperature may be due to the low thermal conductivity of the acid slag resulting in less chilling of the metal in the ladle. It is most probable that there are other differences between acid and basic metal, not yet explained and in fact to the experienced eye the two metals are different when in the fluid state.

In spite of the apparent simplicity of the acid melting, there are precautions the omission of which lessen the efficiency of the process. For example, many operators do not properly control the condition of the slag. An acid slag at the time of pouring is, or should be, very silicious. Early in the process, a few shovels of sand should be added. This sand serves the double purpose of deoxidizing the metal and satisfying the bath with silica, which otherwise is taken from the hearth itself.

In spite of the simplicity of the acid process, the writer is in favor of the basic process in most circumstances. Many experienced foundrymen state that acid steel is in itself better suited for castings, and also that basic steel almost inevitably contains slag inclusions. With this latter statement, the author does not agree, and he believes that many foundries now operating acid would not be doing so if at the time of deciding on the acid process complete information had been available as to the basic process. In any case it is obvious that, with given conditions, a steel of better analysis will be produced by the basic than by the acid process, and the author's experience tells him that this improved composition does not necessitate any great prolongation of the process or appreciably increased conversion costs.

Assuming that acid metal is better than basic metal of the same apparent chemical composition, the author's opinion is that the place for acid operation is not the average steel foundry where only one furnace is available. Acid operations are suited to larger outputs where the chemical refining can be done in a basic furnace, with a final treatment in an acid furnace. Another possible place for the acid electric-steel process is in the production of steel of crucible quality, where the selling price of the finished product allows the purchase of selected raw material.

Preliminary Report on Foundry Training

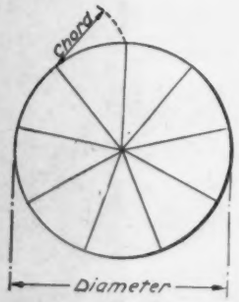
As a result of experience gained while acting as superintendent, United States training service, department of labor, Charles C. Schoen has prepared a preliminary report on a proposed system for training foundry operatives. Dr. Richard Moldenke has written an introduction, reviewing briefly the evolution of the foundry industry from the primitive methods in vogue during the stone and bronze ages down to the highly efficient ones in use at the present time.

While admitting that the foundry business, taken as a whole has reached a high state of development the report deplores the fact that the specialization in the industry has tended to lower the knowledge and skill of the individual molder. The report concludes by saying, "A sufficiency of young blood must be attracted to the existing shops and trained in the fundamentals of the art of molding and allied branches, so that the fast waning supply of skilled molders may be kept up and increased. The molders of the past, with all their limitations and handicaps were true artists in their way. As individuals they have turned out many a brilliant captain of industry, and collectively they have enabled the making of lines of work only possible with serviceable castings which have been fundamental in the progress of the work. Unless their knowledge is transmitted to a younger generation and funded by thorough training, the art of making castings is bound to go backward."

It is pointed out that this report is the first attempt toward a definite outline and that many changes must be made before it can be accepted as final. The recommendations which are made have been divided into four sections as follows: Apprenticeship training; upgrading system; foremanship training, and outlines for the guidance of instructors. A tentative plan has been worked out in detail covering the proposed methods to be used in instructing each of these classes. Special stress is laid upon the fact that where there is any cost attached to the course, better results will be gained by having firms and students pay a proportional share. In the case

LENGTHS OF CHORDS FOR SPACING CIRCLES

By W. L. Tryon



If the diameter is in even feet or even inches, the chords can be found directly from the tables below. If the diameter is in feet and inches, add the chord corresponding to the number of even feet to the chord corresponding to the number of even inches in the diameter. For example, find the chord used for spacing the circumference of a circle 6 feet 2 inches in diameter into nine equal spaces.

From table with diameter in feet, chord for 9 spaces, 6 feet.... = 24.6254
From table with diameter in inches, chord for 9 spaces, 2 inches = .6840

Therefore chord for 6 feet, 2 inches, 9 spaces..... = 25.3094

The table for additional fractions is used in the same manner. For 6 spaces, the chord is equal to the radius.

No. of spaces	Length of Chord When Diameter is 1 ft.	2 ft.	3 ft.	4 ft.	5 ft.	6 ft.	7 ft.	8 ft.	9 ft.	10 ft.
3	10.3923	20.7846	31.1769	41.5692	51.9615	62.3538	72.7461	83.1384	93.5307	103.9230
4	8.4853	16.9706	25.4558	33.9411	42.4264	50.9117	59.3970	67.8822	76.3675	84.8528
5	7.0534	14.1068	21.1603	28.2137	35.2671	42.3205	49.3740	56.4274	63.4808	70.5342
7	5.2066	10.4132	15.6198	20.8264	26.0330	31.2396	36.4462	41.6528	46.8594	52.0660
8	4.5922	9.1844	13.7766	18.3688	22.9610	27.5532	32.1454	36.7376	41.3298	45.9220
9	4.1042	8.2085	12.3127	16.4170	20.5212	24.6254	28.7297	32.8339	36.9382	41.0424

No. of spaces	Length of Chord When Diameter is 1 in.	2 in.	3 in.	4 in.	5 in.	6 in.	7 in.	8 in.	9 in.	10 in.	11 in.
3	.8660	1.7321	2.5981	3.4641	4.3301	5.1962	6.0622	6.9282	7.7942	8.6603	9.5263
4	.7071	1.4142	2.1213	2.8284	3.5355	4.2426	4.9497	5.6569	6.3640	7.0711	7.7782
5	.5878	1.1756	1.7634	2.3511	2.9389	3.5267	4.1145	4.7023	5.2901	5.8779	6.4656
7	.4339	.8678	1.3017	1.7355	2.1694	2.6033	3.0372	3.4711	3.9050	4.3388	4.7727
8	.3827	.7654	1.1481	1.5307	1.9134	2.2961	2.6788	3.0615	3.4442	3.8268	4.2095
9	.3420	.6840	1.0261	1.3681	1.7101	2.0521	2.3941	2.7362	3.1782	3.4202	3.7622

No. of spaces	Length of Chord to be Added for Each Additional Fraction of 1/8 in.	1/4 in.	3/8 in.	1/2 in.	5/8 in.	3/4 in.	7/8 in.
3	.1083	.2165	.3248	.4330	.5413	.6495	.7578
4	.0884	.1768	.2652	.3536	.4419	.5303	.6187
5	.0735	.1469	.2204	.2939	.3674	.4408	.5143

No. of spaces	Length of Chord to be Added for Each Additional Fraction of 1/8 in.	1/4 in.	3/8 in.	1/2 in.	5/8 in.	3/4 in.	7/8 in.
7	.0542	.1085	.1627	.2169	.2712	.3254	.3796
8	.0478	.0957	.1435	.1913	.2392	.2870	.3348
9	.0427	.0855	.1283	.1710	.2138	.2565	.2993

(Continued on Data Sheet No. 294)

LENGTHS OF CHORDS FOR SPACING CIRCLES

By W. L. Tryon

(Continued from Data Sheet No. 293)

No. of spaces	Length of Chord When Diameter is 1 ft.	2 ft.	3 ft.	4 ft.	5 ft.	6 ft.	7 ft.	8 ft.	9 ft.	10 ft.
10	3.7082	7.4164	11.1246	14.8328	18.5410	22.2492	25.9574	29.6656	33.3738	37.0820
11	3.3838	6.7616	10.1424	13.5232	16.9040	20.2847	23.6655	27.0463	30.4271	33.8079
12	3.1058	6.2117	9.3175	12.4233	15.5291	18.6350	21.7408	24.8466	27.9525	31.0583
13	2.8718	5.7436	8.6154	11.4872	14.3589	17.2307	20.1025	22.9743	25.8461	28.7179
14	2.7602	5.3405	8.0107	10.6810	13.3512	16.0215	18.6917	21.3620	24.0322	26.7025
15	2.4949	4.9899	7.4848	9.9798	12.4747	14.9696	17.4646	19.9595	22.4545	24.9494
16	2.3411	4.6822	7.0233	9.3643	11.7054	14.0465	16.3876	18.7287	21.0698	23.4108
17	2.2050	4.4100	6.6150	8.8200	11.0250	13.2300	15.4350	17.6400	19.8449	22.0499
18	2.0838	4.1676	6.2513	8.3351	10.4189	12.5027	14.5864	16.6702	18.7540	20.8378
19	1.9751	3.9503	5.9254	7.9005	9.8757	11.8508	13.8259	15.8011	17.7762	19.7513
20	1.8772	3.7544	5.6316	7.5089	9.3861	11.2633	13.1405	15.0177	16.8949	18.7721
21	1.7885	3.5770	5.3655	7.1540	8.9425	10.7310	12.5195	14.3081	16.0966	17.8851
22	1.7078	3.4156	5.1233	6.8311	8.5389	10.2467	11.9544	13.6622	15.3700	17.0778
23	1.6340	3.2680	4.9020	6.5360	8.1700	9.8040	11.4380	13.0720	14.7060	16.3400
24	1.5663	3.1326	4.6989	6.2653	7.8316	9.3979	10.9642	12.5305	14.0968	15.6631
25	1.5040	3.0080	4.5120	6.0160	7.5200	9.0240	10.5280	12.0320	13.5360	15.0400

No. of spaces	Length of Chord When Diameter is 1 in.	2 in.	3 in.	4 in.	5 in.	6 in.	7 in.	8 in.	9 in.	10 in.	11 in.
10	.3090	.6170	.9271	1.2361	1.5451	1.8541	2.1631	2.4721	2.7812	3.0902	3.9992
11	.2817	.5635	.8452	1.1269	1.4087	1.6904	1.9721	2.3539	2.6356	2.8173	3.0991
12	.2588	.5176	.7765	1.0353	1.2941	1.5529	1.8117	2.0706	2.3294	2.5882	2.8470
13	.2393	.4786	.7179	.9573	1.1966	1.4359	1.6752	1.9145	2.1538	2.3932	2.6325
14	.2225	.4450	.6676	.8901	1.1126	1.3351	1.5576	1.7802	2.0027	2.2252	2.4477
15	.2079	.4158	.6237	.8316	1.0396	1.2475	1.4554	1.6633	1.8712	2.0791	2.2870
16	.1951	.3902	.5853	.7804	.9755	1.1705	1.3656	1.5607	1.7558	1.9509	2.1460
17	.1837	.3675	.5512	.7350	.9187	1.1025	1.2862	1.4700	1.6537	1.8375	2.0212
18	.1736	.3473	.5209	.6946	.8682	1.0419	1.2155	1.3892	1.5628	1.7365	1.9101
19	.1646	.3292	.4938	.6584	.8230	.9876	1.1522	1.3168	1.4814	1.6459	1.8105
20	.1564	.3129	.4693	.6257	.7822	.9386	1.0950	1.2515	1.4079	1.5643	1.7208
21	.1490	.2981	.4471	.5962	.7452	.8943	1.0433	1.1923	1.3414	1.4904	1.6395
22	.1423	.2846	.4269	.5693	.7116	.8539	.9962	1.1385	1.2808	1.4231	1.5655
23	.1362	.2723	.4085	.5447	.6808	.8170	.9532	1.0893	1.2255	1.3617	1.4978
24	.1305	.2611	.3916	.5221	.6526	.7832	.9137	1.0442	1.1747	1.3053	1.4358
25	.1253	.2507	.3760	.5013	.6267	.7520	.8773	1.0027	1.1280	1.2533	1.3787

No. of spaces	Length of Chord to be Added for Each Additional Fraction of 1/8 in.	1/4 in.	3/8 in.	1/2 in.	5/8 in.	3/4 in.	7/8 in.
10	.0386	.0773	.1159	.1545	.1931	.2318	.2704
11	.0352	.0704	.1056	.1409	.1761	.2113	.2465
12	.0323	.0657	.0981	.1294	.1618	.1941	.2265
13	.0299	.0598	.0897	.1197	.1496	.1795	.2094
14	.0278	.0556	.0834	.1113	.1391	.1669	.1947
15	.0260	.0520	.0780	.1040	.1299	.1559	.1819
16	.0244	.0488	.0732	.0975	.1219	.1463	.1707
17	.0229	.0459	.0689	.0919	.1148	.1378	.1608

No. of spaces	Length of Chord to be Added for Each Additional Fraction of 1/8 in.	1/4 in.	3/8 in.	1/2 in.	5/8 in.	3/4 in.	7/8 in.
18	.0217	.0434	.0651	.0868	.1085	.1302	.1519
19	.0206	.0411	.0617	.0823	.1029	.1234	.1440
20	.0196	.0391	.0587	.0782	.0978	.1173	.1369
21	.0186	.0373	.0559	.0745	.0932	.1118	.1304
22	.0177	.0356	.0534	.0712	.0889	.1067	.1245
23	.0170	.0340	.0511	.0681	.0851	.1021	.1191
24	.0163	.0326	.0489	.0653	.0816	.0979	.1142
25	.0157	.0313	.0470	.0627	.0783	.0940	.1097

(Continued on Data Sheet No. 295)

THE FOUNDRY DATA SHEET, JULY 15, 1919
Payment will be made for all contributions on foundry and pattern shop practice suitable for publication

Note—This sheet may be cut into two sections [illegible]

of apprentices, this amount could be deducted from their bonus and returned to them provided they complete the course.

It is admitted that local circumstances will govern to a great extent the place and method of imparting instruction, but where it is practicable, it is recommended to have a classroom fitted up in some suitable building. Charts have been prepared showing in a graphic manner the details of every phase of foundry practice, including gray iron, malleable, steel and nonferrous metals. The charts also indicate the proposed method of instruction. Specimens of proposed indenture forms and cards for recording the students' progress are also included in the report.

In what is termed the upgrading system, provision is made for two classes of workers. It is recommended that journeymen molders be absorbed in the apprenticeship system, full allowance being made for previous experience and training. In the case of specialists, like machine molders for instance, the idea would be to teach them all about the subdivisions of that specialty. The subject of compensation is also dealt with and its value as an incentive pointed out.

The third section of the report, foremanship training, is developed under four heads: Centralized instruction room; night school; foremen's associations, and correspondence schools.

Section 4 of the report, an outline of guidance for instructors, deals with the duties of men in these positions. It touches on the personal qualities necessary, and offers suggestions on the most efficient methods of imparting instruction. The report concludes with the recommendation that only practical, efficient instructors be entrusted with the work. As a guide in selecting such men, a table showing the relative value of some of the important qualifications is given.

Straightening Castings With the Torch

BY JOHN HOFFMAN

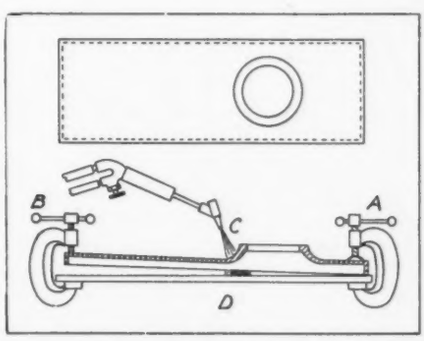
WHEN making light castings it is sometimes difficult to design the pattern to compensate for distortion in cooling. Among the common methods of correcting such faults may be included the designing of the pattern with a slight camber, the curvature of the pattern being reversed with respect to that of the warping tendency; uncovering the casting in the mold or applying heat locally in order to insure uniform cooling, and straightening the warped casting afterward by heating it red hot and then bending it.

For the third method the oxyacetylene flame may often be employed to advantage to bring the portion that is to be bent up to the proper temperature. The particular advantages of the oxyacetylene flame for the purpose are the rapidity with which the heating may be accomplished and the case with which it may be controlled, that is, localized or spread over a considerable area at will. An Oxweld oxyacetylene blowpipe was employed in this way by a certain foundry to correct several hundred gray iron castings of light weight and intricate form.

The castings in this case were apparatus cover plates about 3 feet in length and 1 foot in width, the material being only a fraction of an inch in thickness. They were out of true to the extent of about ½-inch in the total length of 3 feet. The accompanying illustration represents a section lengthwise through the center, give an approximate idea of these castings, although many of the details are omitted from the sketches. Most of the warping had occurred at the part toward which heat of the flame is directed.

The defect was not discovered until the order was completed and ready for shipment. A final inspection revealed the fact that the castings were not straight and as this was an important factor in the purpose for which they were destined the firm was faced with the alternative of recasting the whole order, with the attendant risk of encountering the same trouble on the second lot, or of finding some way to straighten the existing castings.

As the first method would entail a considerable loss it was decided to



CLAMPS AND JIG FOR HOLDING CASTINGS ALSO METHOD OF APPLYING HEAT. ABOVE, PLAN VIEW OF CASTING

try straightening a few of the castings. If the experiment proved successful they could all be treated in the same way.

Special jigs were devised for holding the castings. The accompanying illustration shows on an exaggerated scale the procedure adopted; the clamp *A* held one end of the casting tight against the jig, while heat from the blowpipe flame *C* was distributed evenly across the entire casting at the warped section, clamp *B* being screwed down simultaneously. By the time that clamp *B* had brought its end of the casting down to the jig, the shim *D* assured sufficient reverse curvature to compensate for the inevitable change of shape that occurs with cooling strains. These several hundred of defective castings came through the treatment absolutely true in form and as sound as ever. The entire reclamation was effected with comparatively little delay and expense, largely owing to the speed with which the oxyacetylene flame supplied the necessary heat and the degree of control which it permitted over the entire operation.

Making Motorcycle Pistons and Cylinders

By H. E. Diller

Question:—We are taking up the manufacture of air-cooled motorcycle cylinders and pistons and we would greatly appreciate it if you would let us know the prevailing practice in the States for making such castings.

Answer:—Regarding the metal, we find that most foundries are using from 10 to 15 per cent of steel in the charge. Some manufacturers use charcoal iron in the mixtures, ranging from 10 to 25 per cent while others use the coke iron and scrap. It has been found advantageous to flux well with limestone and to add a small amount of fluorspar on each charge, approximately two pounds to a ton of metal. Too much fluorspar will be detrimental, causing an excessive loss of silicon in the metal and giving trouble around the tuyeres, so that when either of these actions are noted it is necessary to cut down the fluorspar.

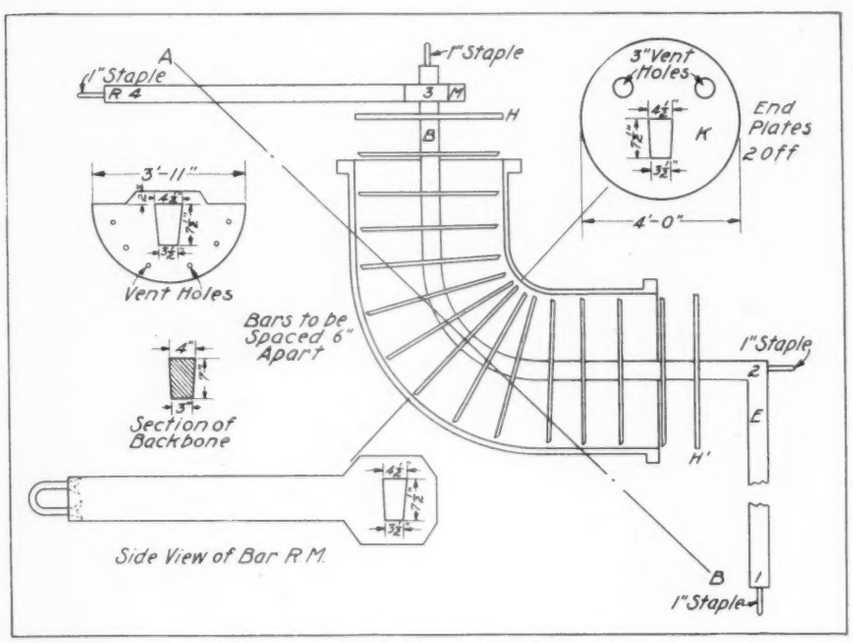
The methods and arrangement of shops making cylinder and piston castings were described in THE FOUNDRY under the following heads: "Efficiency Production of Automobile Cylinders," July, 1916; "Gray-Iron Foundry Designed to Save Manpower," June, 1918; "Annealing Gray-Iron Cylinders," June, 1918, and "Making a Pattern for a Gas Engine Cylinder," August, 1918.

Patternmaking and Molding Tips

Making an Arbor for a Skeleton Pattern Elbow—An Easily Constructed Miter Joint Clamp—How to Avoid Tucking Bars—Eliminating the Cope Core Print

A CONVENIENT form of core arbor, suitable for use with skeleton patterns, is shown in the accompanying illustration. This style of arbor may be employed for any shape or size of pipe; in this instance a 48-inch diameter elbow has been chosen, as it furnishes interesting problems in lifting and securing the core. The arbor is quite easy to make as all the pieces are cast separately in open sand and assembled afterward. The end has been removed. For this purpose, solid bearings are built up under the four points, 1, 2, 3 and 4. The arbor rests on these four points while the core is being rammed. When the mold is finished and the core lowered back into its place the arbor will again rest on the same four points rendering a chaplet unnecessary.

By building up standards over the same points on the cope side, the core can be held down without a chaplet



CORE ARBOR SHOWING DETAILS AND METHOD OF ASSEMBLY

plate H^1 is slipped on first, followed by the wings, enough of them being provided to have one every 6 inches; next comes the end plate *H* and last of all the bar *RM*. They are all tightened in their places with wooden wedges except the end plates *K* and the bar *RM*. It is safer to fasten these with iron wedges. The end plates are complete circles, 1 inch thick, the full size of the core; the wing bars are only half circles, 1 inch less in diameter than the core and ¾ inch in thickness. The holes in the ends and bars are made ½ inch wider and higher than the size of the backbone.

The object in having the outriggers *RM* and *E* at the ends of the arbor is to provide something to hook into when lifting the core in and out of the mold. They also serve as anchors to hold the core in place after the pattern at the turn. However, if there is no objection to using chaplets, it will be safer to put one on, for sometimes the arm at 3 is a loose fit, and in that case the core will be sure to roll over enough to cut through.

There are no overall dimensions given because elbows of the same diameter vary in length and degree. In any event the backbone of the arbor will need to be 18 inches longer than the pattern at each end. This will allow 8 inches for a print; and outside of that, 10 inches will be found little enough in the case of the end carrying the loose arm *RM*. In order to facilitate lifting the core, 1-inch loops are cast in each end of the arbor.

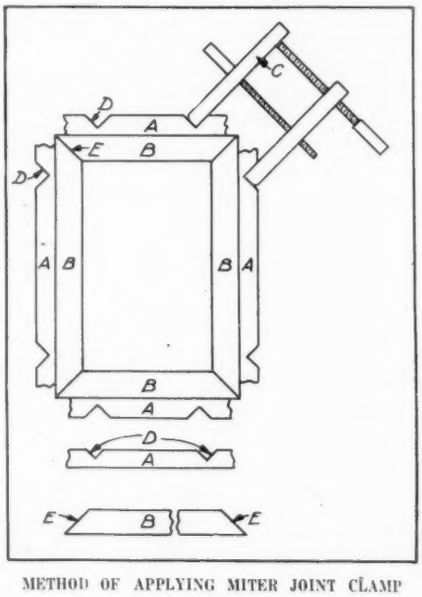
The length of the tail pieces *E* and *RM* will depend on the curve of the elbow. In any event they must be long enough to intersect a line *AB* drawn through the center of the pattern at right angles to the medium radius, as shown.

Miter Joint Clamp

By William Ballantine

The usual way to hold the mitered joints on a pattern frame together until the glue sets is by driving a pinch dog or corrugated fastener across each corner. The objection to this method is that it always leaves marks which have to be filled up afterward.

The accompanying illustration, which is self explanatory, shows a method of clamping miter joints which is simple, easily made and which leaves no unsightly marks when it is taken away. The pieces marked *A* are cut from scrap material and should be about the same thickness as the frame on which they are to be used; *B B* are the sides and ends of the frame with



METHOD OF APPLYING MITER JOINT CLAMP

CLAMP

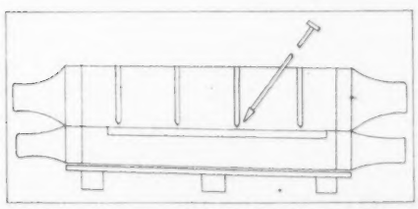
mitered joints; *C* is the common wood clamp found in all pattern shops; *D* is the side of the notch in the piece marked *B;* it must be parallel to the miter joint *E*.

In order to use this clamping device, four pieces of scrap wood are selected, two for the sides and two for the ends about the same length as the sides and ends of the pattern respectively. Notches are then cut near the ends of these pieces as shown at *D*.

Having glued the joints well, the four pieces of the frame are assembled on the bench or layout board, the clamp strips are placed in position and a pattermaker's wooden screw clamp adjusted at each corner. The clamps are each tightened a little in turn until they are all tight. In making joints of this kind, care should be taken to see that the glue is not too thin. The end grain of the wood will absorb a great deal of glue; in fact in cases of this kind it is better to size the ends with glue and let them stand a short time, then apply more glue before clamping them together.

How to Avoid Tucking Bars

There is a lot of time wasted in tucking bars with the fingers. In some instances it is necessary to do so but these instances are very few. The trouble with many molders is that they do not think about their work as they go along. Nothing will move them out of a rut. Others again are in a rut from following a certain method blindly. They are willing to try something else provided there is some one to show them the way, but failing either advice or example they drift along doing the same old things in the same old way. The average molder holds his rammer nearly vertical no matter whether he is ramming a cope or drag. That position is all right in the case of a drag; the space is all open and the sand is packed



HOLDING RAMMER IN THIS POSITION ELIMINATES NECESSITY OF TUCKING BARS WITH THE FINGERS

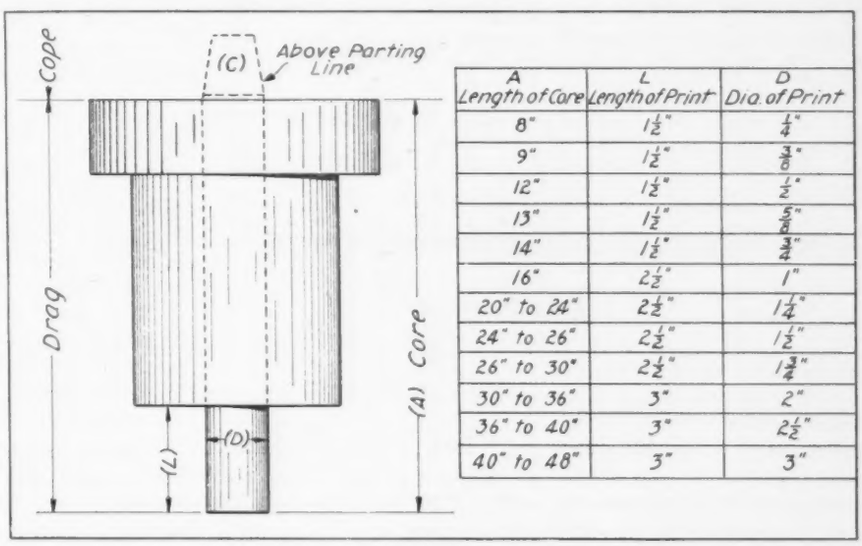
in even layers but in the case of a cope it is different for then, usually, there are the bars to contend with, and unless the bars are tucked first there will be a soft streak under each one when the cope is lifted, all of which of course meant a lot of extra work.

It is not necessary in the great majority of cases to finger tuck the bars to insure a firm surface. If the rammer be held in the position shown in the accompanying illustration during the first ramming, reversing the position of course for each side of the bar, it will be found that the sand will pack as firmly under the bars as elsewhere. Considerable time is saved by having a cope rammed properly. In many instances the necessity of rolling it over is avoided and it may be finished overhead. This is an important consideration in a congested shop where it is often a problem to find enough room in which to roll over a cope of any considerable size.

Eliminating the Cope Core Print

By M. E. Duggan

During a recent discussion in our pattern shop some of the apprentices, and even several of the old-timers, made inquiry regarding the purpose of the cope core print and whether, when a casting is to be made with a vertically cored hole, the pattern should be fitted with a core print. Furthermore, inquiry was made as to whether a casting can be produced without the aid of a cope core print and if so, whether this method is acceptable to the molder and is in accordance with modern foundry practice. As a result of this discussion I compiled some data which I thought might be of interest to other patternmakers.



A Length of Core	L Length of Print	D Dia. of Print
8"	1½"	¼"
9"	1½"	⅜"
12"	1½"	½"
13"	1½"	⅝"
14"	1½"	¾"
16"	2½"	1"
20" to 24"	2½"	1¼"
24" to 26"	2½"	1½"
26" to 30"	2½"	1¾"
30" to 36"	3"	2"
36" to 40"	3"	2½"
40" to 48"	3"	3"

GLAND PATTERN AND TABLE GIVING LENGTHS OF CORES THAT MAY BE SET WITHOUT COPE PRINTS

In the accompanying illustration is shown a sketch of a gland for which a pattern is to be made. This is a comparatively simple pattern to produce, yet it may be made in five or six different ways. Before making the pattern, it is necessary to determine which method is the most suitable. The form shown in the sketch suggests itself as being a desirable method of making and molding a pattern and by coring-out the hole it can be made parallel. The advantage of leaving the hole parallel is that less metal will have to be left for boring, if this is necessary. If the hole is tapered, the large end of the bore will have to have the proper amount of allowance to provide sufficient metal to permit the hole to be bored out true and the smaller end necessarily would have more than the required amount. On the other hand, only a slight amount of taper on the outside would enable the molder to draw the pattern from the mold. Made in this way, it would be molded with the flange uppermost because almost all of the pattern would be embedded in the lower part of the flask.

The cope only would contain the top core print, and even this may be omitted if the hole is to be bored, since the lower core print will hold the core sufficiently in small work unless the core must be centered absolutely true.

When I learned my trade I was instructed to place a cope print on the pattern so that when the two parts of the mold are being assembled, or rather when the cope is being put in place and if the core has not been placed quite upright, the tapered end of the core may still adjust itself in the conical impression and thus correct any slight error of position of the core. For many years I followed these instructions to the letter. Many times I placed a cope and a drag print on a pattern only 1 inch in thickness, but I am glad that I know better today. A core of almost any length can be set and held in a vertical position without a cope core print. The table accompanying the illustration gives the diameter of the print, the length of the print and the length of the core that can be set and secured without the aid of the cope print. For example, the greatest length of a core, 1 inch in diameter, that may be set in this way is 16 inches and the length of print recommended is 2½ inches.

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The Perennial Apprentice Problem

EACH year foundrymen are brought more acutely face to face with the problem of increasing the supply of skilled all around foundrymen. This situation has at last reached such a point that the training service of the United States department of labor feels called upon to report on the subject and suggest a remedy. Accordingly the department has developed a tentative plan for training foundry operatives. It is at present being submitted to some of the leading foundrymen of the country for their opinion, and when their recommendations have been submitted to Washington, and the plan modified or enlarged to conform to the expressed views of these experts, measures will be taken by the department to induce foundrymen generally to adopt it.

There are several reasons for this dearth of skilled men. One is the rapid strides the industry has made in recent years; another is the fact that so much of the work is specialized; and another, and perhaps the chief reason is our American system of haste and hurry.

No one wants the bother of teaching apprentices. The owners of foundries do not want to waste any of their foremen's time on the matter, because they are afraid that the apprentices will leave as soon as their terms have expired. The foreman does not care to waste his time teaching men all the branches of the trade because there usually is no provision made in the estimates for expenses of that kind. He is given a certain number of workmen and is supposed to show a profit on the labor of each. For that reason the apprentice is apt to be taught nothing but the most elementary work. With a very little training he can do as much simple work as a skilled man and instead of a liability he becomes an asset. This is a selfish policy and like every selfish policy will eventually be its own undoing.

If every foundryman saw to it that his apprentices were taught properly, he would not have to worry over the prospect of any of them leaving when they become journeymen, because others equally well trained would come to him from the shops of his competitors. The cold, hard fact must be faced that if the foundry industry is to be perpetuated, time must be taken to teach the apprentices. It will cost something, it is true, but it may be regarded as an investment and is just as legitimate as taxes, insurance or any other overhead expense.

This fact was recognized until recently in Great Britain where a boy's parent or guardian had to pay a premium to the owner of the foundry for teaching the boy the trade. Under these conditions it became a bargain, and therefore an obligation rested on the proprietor to see that the boy received every opportunity to become a competent workman. The term of service was seven years which is only another proof that they believed in making a thorough job of it.

Modern methods and the demands of the labor unions have cut the time down to four years and the premium has been dispensed with altogether. As a result, foundry managers and owners in Great Britain instead of seeing how much they put in a boy, are now interested like their American cousins in seeing how much they can get out of him. If some concerted action is not taken, and taken soon the foundry industry is bound to suffer; for the apprentices of today will be the foundrymen of tomorrow.

Trade Outlook in the Foundry Industry

STEADY improvement continues in practically all lines of castings manufacture. Betterment which has been remarked from month to month since last November, now approaches the point where many foundries report their plants engaged to capacity with the available labor force. Lack of orders no longer limit foundry activity, but a new element with numerous complications has entered to exert a restraining influence. Labor is becoming increasingly difficult to obtain, particularly through the eastern and central states. The scarcity at the present time has not affected the supply of skilled mechanics, molders, patternmakers and trained men, but common labor is at a premium. Some establishments have had to resort to directing skilled workmen to the clean-up work normally handled by labor gangs. Pouring off large floors in some foundries has been marked by a general call for help from cleaning-room and other departments and even foremen have had to handle the metal. An instance is indicative of conditions and points in some measure to an underlying cause for the present condition. A large foundry engaged in automobile parts production contracted for an extensive addition. The builders force entered on the undertaking with a scant supply of workmen, but soon the foundry was without common laborers, while the contractor had a surplus of help which had flocked to him from the company whose building he was erecting. The building trades with higher wages have taken a percentage of the available labor. The great migration of foreign born back to Europe has taken its quota. These causes taken with the constant milling and shifting of population produced by stringent housing shortage in many centers have taken toll heavily from the foundry labor supply. Many manufacturers with a weather eye to conditions in the near future, already have taken steps to meet the labor shortage. Makers of labor-saving equipment for the foundry report an excellent and improving demand for their products.

Prices of Raw Materials for Foundry Use

CORRECTED TO JULY 10

Iron		Scrap	
No. 2 Foundry, Valley	$26 75	Heavy melting steel, Valley	$19.00 to 20.00
No. 2 Southern, Birmingham	25.00	Heavy melting steel, Pittsburgh	19 00 to 19.50
No. 2 Foundry, Chicago	26.75	Heavy melting steel, Chicago	18.50 to 19.00
No. 2 Foundry, Philadelphia	27.60 to 29.60	Stove plate, Chicago	19.50 to 20.00
Basic, Valley	25.75	No. 1 cast, Chicago	24.50 to 25.00
Malleable, Chicago	27.25	No. 1 cast, Philadelphia	23.00 to 24.00
Malleable, Buffalo	27.25	No. 1 cast, Birmingham	22.00 to 23.00
Coke		Car wheels, iron, Pittsburgh	22.00 to23.00
Connellsville foundry coke	5.00 to 5.50	Car wheels, iron, Chicago	23.00 to 23.50
Wise county foundry coke	7.00 to 7.50	Railroad malleable, Chicago	19 50 to 20.00
		Agricultural malleable, Chicago	18.50 to 19.00

Gray Iron is Active

Practically without exception, gray iron foundries are busy. The heavy shops catering to machine tool builders have been among the last to feel the impetus, but at the present time machine tool manufacturers, through New England, and in Ohio in particular, are placing heavy orders with the foundries which produce their castings. The automobile trade continues to star. Jobbing shops handling this class of work exclusively have orders for over a year ahead. Prevailing prices on this class of work range from 8 to 10 cents per pound at the present time. The price question is one of vital interest to castings manufacturers. Mounting labor costs, and the strong indications of advanced prices on raw materials in most quarters is accepted as demanding a general increase in prices for castings. Exceptions are noted. Some foundrymen in the east, it is stated, are cutting prices sharply. One foundry in New Jersey took an order for medium heavy castings at 3 cents a pound, which would barely cover the cost of the melted iron. A low cost producer quoted a price of 6 cents per pound on certain heavy machinery castings and lost to a competitor who accepted the work at 4 cents. These instances, however, are exceptional. The general tendency is toward higher prices. Scrap, ever the most sensitive barometer of prices, is mounting steadily as may be noted from a comparison of the semimonthly prices carried on this page.

Malleable Improves

Disdainful of the influence of railway orders withheld, the malleable interests continue to develop more business. The agricultural lines which have been sluggish have brightened perceptibly, and a steadily mounting volume of orders is apparent. The automobile shops still have all the work they can handle. With deliveries on standard makes of passenger cars reluctantly and conditionally promised in early September, it is apparent that the saturation point in the demand for automotive vehicles is remote. An order authorizing needed railway car repairs has produced a scattering demand for malleable castings, which is far from constituting a real buying movement for this equipment, and does not pretend to indicate what will be needed when the railroads really are free to buy for their needs. Most malleable plants are working to full labor capacity.

Steel Shops Lagging

Steel foundries which were perhaps the most affected by the cessation of war demands, still are lagging. They have been more strongly affected by the recalcitrant orders for railway equipment than perhaps any other branch of the foundry industry. Truck and tractor plants have in some measure contributed to a revival in the demand for steel castings, and machinery manufacturers in general are adding to the inquiry which is growing, but up to the present most steel foundries are not engaged to over 50 per cent of capacity.

Nonferrous foundries are active, due largely to the building movement, and the general prosperity in machinery lines. Casting copper is quoted at 19c to 19.25c, New York; lead is 5.40c; tin, 71c; antimony, 8.50c to 8.62½c; aluminum No. 12 alloy, producer's price, 31.50c, and open market, 27c to 28c, all based on New York quotation. Zinc is quoted at 7.15c to 7.25c St. Louis. The comparison of nonferrous metals prices for May and June follows:

	Copper	Lead	Zinc	Antimony	Aluminum No. 12
May average	.....	5.111	6.111	7.455	26.00
June average	17.056	5.364	6.544	8.401	26.142

COMINGS AND GOINGS OF FOUNDRYMEN

JOHN A. CAPP, the newly elected president of the American Society for Testing Materials has been an active member of the society since he affiliated with it in 1898. His work has been mostly with committee A-1 on steel, and with committee B-1 on copper wire, and he is at present chairman of both these committees. He has also been of service to the society as a member of the executive committee for the past two years. Mr. Capp received his college training at the University of Pennsylvania where he took a course in mechanical engineering. After completing the course in 1891 he accepted a position in the testing laboratory of the Thomson-Houston Co., Boston. Two years later when this company combined with the Edison Electric Co., Schenectady, N. Y., to form the General Electric Co., Mr. Capp was transferred to the testing laboratory of the Schenectady works. Shortly afterward he was placed in charge of this laboratory. In this position, which he still retains, he has put out all of the specifications under which the General Electric Co. buy their materials.

John Jeppson, superintendent of the Norton Co., Worcester, Mass., since its organization in 1886, recently celebrated his 75th birthday.

F. J. Carrigan, who formerly was at the naval yard foundry at Vallejo, Cal., has been made foreman of the New Consolidated Copper Co. foundry at McGill, Nev.

Ross C. Purdy, research engineer for the Norton Co., Worcester, Mass., will sever his active connection with that company in October and will engage in private engineering practice in Buffalo.

T. B. Foust has resigned as superintendent of the furnace department of the Bon Air Coal & Iron Corp., Lyles, Tenn., to assume active charge on June 1 of the Clarksville Foundry & Machine Works, of which he is president.

G. S. Alston, who for the past three years has been auditor of the Sharon, Pa., plant of the American Steel Foundries, has been transferred to the Alliance, O., plant of that company. A. C. James succeeds Mr. Alston at Sharon.

R. S. Hammond, formerly with the American Steel Foundries, has been appointed Pittsburgh representative for the Whiting Foundry Equipment Co., Harvey, Ill. Mr. Hammond, who succeeds F. J. Page, will open an office at 1224 Fulton building.

H. H. Farr, who received his release as captain in the ordnance in February and accepted a position with the Woodward Iron Co., Woodward, Ala., recently was made assistant foundry superintendent for the Kanawha Mfg. Co., Charleston, W. Va.

John Gillespie has been appointed general superintendent of the Philadelphia Electric Steel Corp., Conshohocken, Pa., a subsidiary of the American Metallurgical Corp., Philadelphia, succeeding A. S. Breithaupt. Mr. Gillespie was in the steel casting department of the Midvale Steel Corp., Philadelphia, for 24 years.

JOHN A. CAPP

Arnold Rees, for four years foreman of the Goyne Steam Pump Co., Ashland, Pa., and more recently with the Birdsboro Steel Foundry & Machine Co., Birdsboro, Pa., has purchased an interest in a foundry in Gouverneur, N. Y., which will be known as the Millard & Rees Iron & Brass Foundry.

William G. Pearce has retired as president of the American Brake Shoe & Foundry Co. to become chairman of the executive committee of that company. Joseph B. Terbell, formerly vice president, has succeeded Mr. Pearce as president. Randolph Ortman, who has been president of one of the company's subsidiaries, has been elected as a director of the controlling company.

L. F. Lemme, who until recently was superintendent of the A. Plamondon Mfg. Co., Chicago, has been made foundry superintendent of the Michigan City Foundry & Machine Co., Michigan City, Ind. George H. Gould, who formerly was foreman with Mr. Lemme at the Plamondon plant, has been appointed assistant superintendent of the Michigan City Foundry & Machine Co. and will supervise core making and foundry detail.

James Whitehead has resigned his position as foreman of the St. Louis Malleable Casting Co. to become superintendent of the pattern department at the Buffalo plant of the American Radiator Co. Mr. Whitehead formerly was foreman patternmaker at the Wilmington Malleable Iron Works of the Eastern Malleable Iron Co., Wilmington, Del., and later superintendent of the pattern department of Abram Cox Stove Co., Philadelphia.

Arthur S. Breithaupt has resigned his position as general superintendent of the Philadelphia Electric Steel Corp., Philadelphia, to engage in the development and sale of metallurgical and plant equipment, together with T. B. MacCabe and F. H. Shaw, formerly superintendent and assistant treasurer of the Philadelphia Electric Steel Corp. The new company will be known as the Triangle Engineering & Equipment Co. and will specialize in electric furnace melting for nonferrous industries.

D. C. Douglas, president of the W. & B. Douglas Pump Co., Middletown, Conn., resigned recently to accept the superintendency of the foundry department of the Chalmers Motor Co., Detroit. Mr. Douglas has been with the Middletown company since 1897 and during this time has worked in all departments, becoming successively superintendent, director, vice president and president. He has been active in machine and foundry circles of New England and has been responsible for many improvements and developments in the company. He assumed his new duties on July 7.

W. T. Hersher, for several years

superintendent of the Bridgeport Malleable Iron Works of the Eastern Malleable Iron Co., Bridgeport, Conn., and who more recently was superintendent of the malleable foundry operated by the Chain Belt Co., Milwaukee, has organized a new foundry which he heads. The new plant will be known as the Great Lakes Malleable Co. and will occupy a plant formerly used by the Maynard Steel Co., Milwaukee. The incorporators of the new company, which is capitalized at $100,000, are W. T. Hersher, F. J. Vea, president of the Stoughton Wagon Co., Stoughton, Wis., and R. F. Eithier, formerly assistant sales manager of the Chain Belt Co.

Obituary

Edwin J. Sherwin, who died recently at his home in Providence, R. I., was a member of the American Foundrymen's association since its inception. During his active career in iron and steel manufacturing lines he was foundry superintendent for the following firms: Platt Iron Works, Dayton, O.; Fairbanks, Morse & Co., Beloit, Wis.; Vulcan Iron Works, San Francisco; Fall River Machine Co., Cuyahoga Falls, O.; Wellman-Seaver-Morgan Co., Akron, O.; General Fire Extinguisher Co., Providence, R. I.; General Electric Co., Pittsfield, Mass.; Blakes & Knowles, Cambridge, Mass.; Fore River Shipbuilding Co., Quincy, Mass.; and more recently the Textile Finishing Machinery Co., Providence, R. I. He also was owner of the Enterprise Foundry Co., Muskegon, Mich. Mr. Sherwin is survived by two sons, one of whom is connected with Brown & Sharpe Co., Providence, R. I., and the other is superintendent of the Wheland Machine Co., Chattanooga, Tenn.

Charles K. Totten, connected with the firm of Edgar M. Moore & Co., Pittsburgh, and previously with the Fort Pitt Foundry, died recently at the Presbyterian hospital, aged 70 years. Mr. Totten was the son of William J. Totten, one of the pioneers in the iron business in Pittsburgh and a member of the firm of Knap & Totten, afterwards known as the Fort Pitt Foundry.

Frank S. Bissell, organizer and head of Bissell & Co., Pittsburgh, stove manufacturers, and more recently connected with the Stove & Range Co. of Pittsburgh, with which the firm of Bissell & Co. some years ago was consolidated, died at his home in Pittsburgh July 4. Mr. Bissell was 87 years old. He was born and resided all his life in Pittsburgh. He had served as director of the Exchange National bank of Pittsburgh for more than 40 years and for a number of years was vice president of that bank.

William A. Bole, vice president in charge of manufacturing for the Westinghouse Machine Co., East Pittsburgh, and for years a conspicuous figure in the foundry industry and in engineering circles, died recently at his home in Pittsburgh, aged 58 years. Mr. Bole suffered a stroke of paralysis about a year ago and had been in ill health since that time. Following his graduation from the Allegheny high school, he took the examination for appointment to West Point. He

EDWIN J. SHERWIN

passed the mental tests successfully but the physical requirements prevented his admission to the academy. He then entered the Western University of Pennsylvania, now the University of Pittsburgh, from which he was graduated in mechanical engineering in 1871. That year he entered the employ of the Westinghouse Machine Co. and remained with that company continuously until his death. In his capacity as vice president of the company he had charge of all of the foundry work. He was prominent in the affairs of several engineering societies, notably the Engineers' Society of Western Pennsylvania, of which he was president in 1900. He also was active in the American Society of Mechanical Engineers; in the Pittsburgh Foundrymen's association and the American Foundrymen's association, serving as vice president of the latter in 1910. He was a member of the Duquesne club of Pittsburgh and of the Engineers club of New York.

William J. Schilling, a retired foundryman, aged 61 years, died recently at his home in Columbus, O. Mr. Schilling conducted a foundry in his home city for a period of 45 years.

Ernest Lister, governor of Washington, who died recently, rose from a position of iron molder in a foundry in Tacoma, Wash., to be the governor of his state. Mr. Lister was born in Halifax, England, in 1870, and early came to this country, locating on the western coast.

Combine Ohio Companies

The Fate-Root-Heath Co., Plymouth, O., has been incorporated with a capital stock of $1,000,000 to take over the business of the J. D. Fate Co., manufacturer of brick and tile-making machinery, and the Root-Heath Mfg. Co., maker of hardware and machinery specialties. The new company is constructing a new foundry, power house and office building. The officers are: J. A. Root, president; C. E. Heath, vice president and general manager; H. F. Root, second vice president; P. H. Root, secretary; H. R. Sykes, treasurer, and H. J. Votaw, sales manager.

Changes Firm Name

Early last month the name of the United Coal Corp. was changed to the Hillman Coal & Coke Co. and the Hillman Coal & Coke Co. took over the jobbing department of the business of the J. H. Hillman & Sons Co., and assumed and will carry out all of the latter company's unfilled orders and contracts covering sales and purchases of coal and coke. Official announcement of these changes also stated that the general offices of the Hillman Coal & Coke Co. will be located in the First National Bank building, Pittsburgh, where the company has leased the entire twentieth and twenty-first floors.

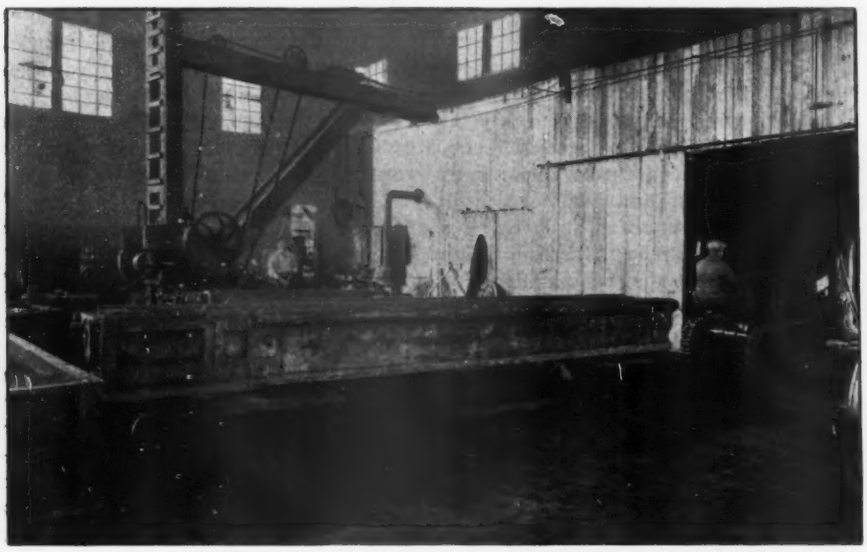
Molded Furnace Linings

A new method of lining side-blow converters has been developed by F. E. Hinners, secretary and treasurer of the George H. Smith Steel Casting Co., Milwaukee. The invention is covered by United States patent No. 1272442. The invention is based on the fact that the lining is formed in sections by ramming up a suitable mixture of fine clay and ganister in core boxes in the same manner as ordinary cores are made. The forms are then dried in a core oven after which they may be kept in stock indefinitely, or may be placed at once into their position in the converter shell.

To do this they can be handled by a crane and but little time is required. The joints are thoroughly grouted with fireclay.

While the lining may be patched with fireclay when in need of repairing, it has been found better to shake out the lining after about 70 heats have been run and reline the converter. This is made advisable by the low cost of relining.

One of the advantages claimed for this method of lining is that the time required to reline a converter is shortened. It is said a converter can be used one day and relined at night so as to be in working condition the next day. Long life and low cost are two other advantages claimed for this molded lining. Although this lining was developed for use in converters, it can also be adapted to electric and other melting furnaces. Its use in connection with such furnaces is covered by the patent.



TRACTOR HAULING A 4-TON LATHE BED FROM THE FOUNDRY TO THE MACHINE SHOP

Using Tractors for Hauling in the Foundry

A machine which was primarily designed to meet agricultural and commercial conditions but which gradually is assuming the burden of intraplant hauling is that which is known from its mode of travel as the crawl tractor. At present there are some of these engaged in nearly every phase of endeavor where material has to be moved from one place to another. The accompanying illustration shows a tractor of this type manufactured by the Cleveland Tractor Co., Cleveland.

One of the factors which make the capabilities of this tractor possible is its track-laying type of construction. It picks up and lays down its own track like the giant "tanks" which did such marvelous work on the battlefields of Europe. This permits it to pass over ordinary obstructions with ease.

The track belt and sprockets are designed for long service. The sections are so constructed that filling or packing with mud is prevented, and guards are provided to prevent dirt and mud from falling within the track. The sprocket and sheave wheels over which the tracks run are equipped with roller bearings. All bearings on the machine are enclosed to render them dust and dirt proof.

The motor is the four-cylinder heavy-duty type with protected overhead valves, and cylinders 3¾-inch bore by 5½-inch stroke. It is equipped with an automatic throttle governor which is set in the desired position and then automatically maintains the speed of the motor in both motive and stationary work. This feature takes care of the various load conditions without constant attention from the operator.

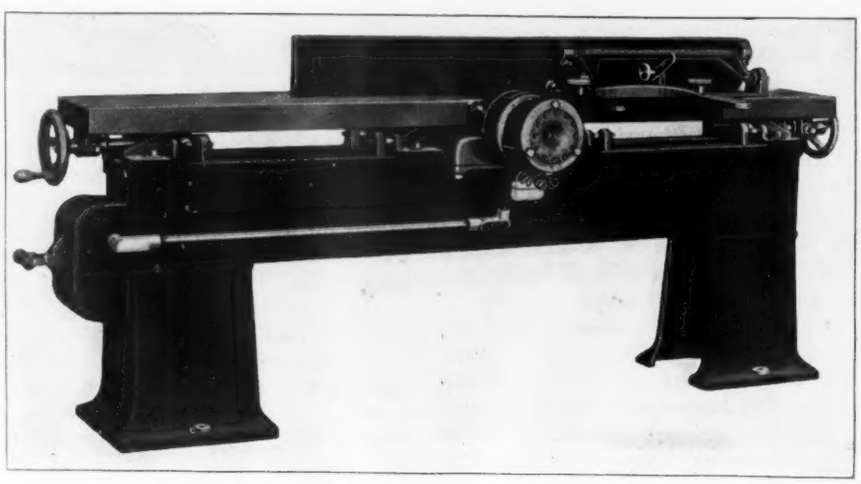
Ease of handling and control is an important feature. Steering is effected by a slight turn of the steering wheel which tightens a brake band on a drum on one side or the other of the differential and through planetary gears, retards the speed of the drive wheel and track on one side of the machine and accelerates the speed on the opposite side, thereby causing one side of the tractor to travel around the other. The power required in turning is furnished by the motor. The tractor's small size enables it to pass through ordinary factory doors, along narrow aisles and places where a team and wagon could not travel. Its makers state that it can be turned around in a 12-foot circle and that it can negotiate practically a right-angle turn. The power is ample for heavy foundry hauling.

Special Welding Rods

Modern welding methods furnish an interesting chapter in industrial development. Seven years ago autogenous welding was practically unknown and now there is hardly an industry in which it is not used to some extent.

Coincident with the development of the art itself came improvements and specializations in the material used. Seven or eight years ago iron wire with a small percentage of carbon served as a filler for all welding purposes; at the present time there are several varieties of filler each adapted to welding particular kinds of ferrous metals.

The Central Steel & Wire Co., Chicago, is among those responsible for the specialization of welding filler. The work of this company began



MOTOR DRIVEN HAND PLANER AND JOINTER

some time ago when expert metallurgists employed by the company were instructed to investigate the subject of welding as a whole. As a result of their preliminary investigation, they proposed the adoption of the present forms of rods and wire made by this company. They also discovered that a special treatment of welding wire was advisable to differentiate between electric and acetylene welding.

Having adopted this primary division, the next step was to distinguish between fillers suited to welding one sort of metal and not suited to another. They found, for instance, that the same filler would not give the uniform results if used on nickel and vanadium steel. Tests were made to determine the proper analysis for welding materials suited to different metals and as a result eight standard fillers were developed.

Motor Driven Planer

A new type of direct mounted motor drive hand planer and jointer is shown in the illustration on the opposite page. It has a three-knife cylinder driven by a three-phase, 60-cycle, 220-volt, alternating current motor running at 3600 revolutions per minute.

On the outer end of the cylinders where the pulley usually is mounted, the cylinder is shaped to receive the rotor of the motor. On the outside of this rotor and concentric with it is the stator of the motor held by means of the adapter and the outer end of the cover. Ball bearings are provided at all points supporting rotating parts. The planer is manufactured by the Oliver Machinery Co., Grand Rapids, Mich.

The Electric Furnace Co., Alliance, Ohio, has shipped one of its standard nose tilting type furnaces to the United States navy yard at Washington, to be used in the government brass foundry there.

What the Foundries Are Doing

Activities of the Iron, Steel and Brass Shops

C. L. Probst, Lynchburg, Va., is reported planning to erect a foundry.

The plant of the Henry Miller Foundry Co., Canton, O., recently was slightly damaged by fire.

Nichols & Shepard, Battle Creek, Mich., are reported contemplating the erection of a foundry.

A foundry and machine shop will be erected shortly by the Owosso Bronze Bearing Co., Owosso, Mich.

No building operations will be undertaken by the Marion Foundry Corp., Marion, Ind., until next year.

C. A. Goldsmith, 270 Thomas street, Newark, N. J., has started on the erection of a pattern shop.

The Hydraulic Press Mfg. Co., Mt. Gilead, O., is reported planning the erection of a foundry.

Erection of a foundry addition, 40 x 120 feet, is planned by the Novelty Mfg. Co., Sterling, Ill.

An addition will be erected at the plant of the Sivyer Steel Castings Co., Milwaukee.

The Reeder Welding Co., Sacramento, Cal., is erecting a foundry and contemplates other extensions.

The William G. Sheehan Construction Co. has the contract to erect a plant for the Thacher Foundry & Propeller Corp., Albany, N. Y.

Work has started on the erection of a large foundry addition at the plant of the Defiance Machine Works, Defiance, O.

The Canton Foundry & Machine Co., Canton, O., is reported to be in the market for a small amount of new equipment.

Ground has been broken for the erection of a foundry, 50 x 50 feet, for the Hanford Iron Works, San Bernardino, Cal. W. J. Hanford is president.

Erection of an addition, 21 x 65 feet, is contemplated by the American Manganese Bronze Co., Rhawn and Hegerman streets, Philadelphia.

Ground has been broken for the erection of a machine shop and foundry for the E. W. Bliss Co., Adams and Plymouth streets, Brooklyn, N. Y.

Erection of a plant addition, 60 x 80 feet, is contemplated by the Dayton Malleable Iron Co., Ironton, O.

The American Metallurgical Corp., Franklin Trust building, Philadelphia, plans to enlarge its plant and will install additional electric furnace units.

Work has started on the erection of an addition, 100 x 142 feet, to the foundry of the Iowa Malleable Iron Works, Fairfield, Iowa.

A contract has been let by Franklin Williams, Inc., 39 Cortlandt street, New York, for the erection of a foundry and machine shop, 47 x 150 feet.

Authority to increase its capital from $100,000 to $225,000 recently was granted the Muncie Foundry & Machine Co., Muncie, Ind.

The Billings & Spencer Co., Hartford, Conn., will build an addition to its plant, which will include a foundry, 60 x 80 feet.

James A. Reese, Blytheville, Ark., recently purchased an iron foundry in Tennessee, and is reported planning to move the plant to Blytheville.

Construction of a foundry and office building, 80 x 600 feet, is contemplated by the American Truck Co., Chicago. Plans are now being drawn.

Enlargement of its foundry will be undertaken shortly by the Banner Machine Co., Columbiana, O. The addition will be 60 x 75 feet.

Work has started on the erection of a pattern storage building at the plant of the American Frog & Switch Co., Hamilton, O.

The Ann Arbor Machine Co., Ann Arbor, Mich., has been purchased by Detroit interests and will be known as the Production Casting Co.

O. J. Southworth and associates, Blytheville, Ark., are reported planning the erection of a foundry and machine shop, 25 x 100 feet.

A pattern shop, 40 x 70 feet, will be erected by the R. Hitchcock Modern Pattern Co., 3241 Thirtieth street, Minneapolis.

The Atlas Foundry Co., 206 Coit street, Irvington, N. J., is reported contemplating the erection of a plant addition, 60 x 100 feet.

The A. T. Hye & Sons Co., East Spring street, Columbus, O., is reported planning the erection of an addition to its stove plant, 300 x 400 feet.

A foundry, 70 x 146 feet, will be erected at the plant of the Philadelphia Sash Weight Works, Philadelphia.

A foundry, 200 x 300 feet, will be erected at Waukegan, Ill., by the Pacific Steel & Boiler Co., Tacoma, Wash., according to a current report.

Contracts for the erection of an aluminum foundry recently were let by the Sterling Machine & Stamping Co., Wellington, O.

The plant of the Dominion Foundry Co., Hamilton, Ont., will be closed for a short period, during which time new electric ovens will be installed.

Erection of a foundry, 50 x 130 feet, is reported being contemplated by the Mathieu Foundry Co., St. Joseph, Mich. William Mathieu is in charge.

James Spence, 921 Garfield avenue, Jersey City, N. J., has had plans drawn for the erection of an addition to his foundry, 44 x 60 feet.

The American Malleable Casting Co., Marion, O., contemplates the erection of an addition to its foundry, 60 x 70 feet.

Plans are being drawn for the erection of a foundry, 120 x 240 feet, for the American Shell Co., Paterson, N. J. James T. Gordon is in charge.

Large additions to its plant are planned by the J. P. Devine Co., Buffalo. Foundations for a new foundry, 90 x 225 feet, are being constructed.

A report that the Pawling & Harnischfeger Co., Milwaukee, was contemplating the erection of a steel foundry, has been denied by the company.

Kayser & Hagderdown, Montgomery, Ala., are erecting a machine shop and foundry, 150 x 320 feet, at New Orleans, La.

George H. Thacher & Co., Albany, N. Y., manufacturer of castings, grate bars, etc., plans to erect a machine shop, and install an additional cupola.

The Hay Foundry & Iron Works, Plum Point Lane, Newark, N. J., has filed plans for the erection of a plant addition.

The Josam Mfg. Co., Michigan City, Ind., is reported contemplating the erection of a foundry. J. M. Hirschstein is architect.

The North West Foundries Co., Rochester, N. Y., recently awarded a contract for the erection of an addition to its foundry. A. Fiederich & Sons, 710 Lake avenue, Rochester, have the contract.

Erection of a foundry in East Moline, Ill., is contemplated by the Moline Plow Co. The building will be of reinforced concrete construction and will be modern in every detail.

The E. H. Bardes Range & Foundry Co., 2619 Cobrain avenue, Cincinnati, contemplates the erection of an addition to its plant. E. H. Bardes is president of the company.

Plans are being drawn for the erection of a foundry and power house, 50 x 200 feet, for W. S. Hoffman, 329 Tuckel street, Syracuse, N. Y. M. E. Granger is architect.

The Chicago Hardware Foundry Co., North Chicago, Ill., will increase its capital from $400,000 to $500,000 and is reported planning to erect a foundry and warehouse.

Contracts have been awarded by the Singer Mfg. Co., Elizabeth, N. J., for the construction of a 176 x 252-foot foundry building. The Turner Construction Co. has the contract.

Three additions will be erected at the plant of the Star Foundry Co., Troy, O. One addition will be 25 x 48 feet and another 85 x 90 feet. W. T. Anglemeyer is president.

Engineers Day & Zimmerman, 511 Chestnut street,

Philadelphia, shortly are expected to call for bids for the erection of a foundry at Parkersburg, W. Va. The name of the owner is withheld.

The Great Lakes Malleable Iron Co., Milwaukee, will be enlarged to facilitate the manufacture of automobile accessories. Thomas C. Perkins is secretary and treasurer.

Among the recent incorporations is that of the Interstate Foundry Co., Waterloo, Iowa, which is capitalized at $25,000. The incorporators are G. E. Metcalf and E. A. Lamb.

The General Equipment Co., Conneaut, O., Charles Lovring, manager, is reported planning to proceed with the construction of a foundry, plans for which were drawn some time ago.

Amended articles of incorporation have been filed by the Southern Foundry & Mfg. Co., Owensboro, Ky., increasing its capital from $400,000 to $450,000. J. J. Trefz is president.

James M. Forsythe, McKinney, Tex., John C. Armbruster, and Hugh C. Dodge, both of Dallas, Tex., recently acquired the Dug-McNey Foundry, Temple, Tex., and are reported planning to enlarge the plant.

The D. D. Mills Co., Jersey City, N. J., has been incorporated with $18,000 capital, to engage in the foundry business. Augustine Davis, William G. McCune and William Lester, Plainfield, N. J., are the incorporators.

Among the recent incorporations is that of the David E. Allen Yonkers Foundry, New York. The company which is capitalized at $25,000, was incorporated by H. Whitehead, W. S. Pronk and D. E. Allen, Yonkers, New York.

The Detroit Gray Iron Foundry Co., Detroit, is erecting a new cleaning and shipping room and pattern shop, the building being 2-stories, 80 x 140 feet. The company is buying sand blast, compressor and considerable new cleaning room machinery.

A charter has been issued to the Williamsport Foundry & Machine Works, Williamsport, Pa. The company, which is capitalized at $25,000, was incorporated by Hiram Heller, C. LeRoy Foulk and Calvin H. McCauley Jr.

A recent Ohio incorporation is that of the Belleville Foundry & Machine Co., Belleville, O. The company which is capitalized at $100,000, was incorporated by James P. Wood, Thomas H. Jones, Grover Higgins, Harold G. Mosier and W. B. Cockley.

The Troy Foundy & Machine Co. recently incorporated at Boston under the laws of Massachusetts, will take over the plant of the West Side Foundry Co., Troy, N. Y., and it is expected the buildings will be improved.

A recent New York incorporation is that of the Sherman Brass Foundry Co., which is capitalized at $5000. Incorporators are H. Danzig, S. Shapiro and S. J. Sherman, 226 East 102nd street, New York.

A cupola at the plant of the Barnett Foundry & Machine Co., Irvington, Mass., recently was damaged in a blaze at the plant. The total loss was not estimated.

Bids are being taken for the erection of a foundry, 95 x 105 feet, for the Michigan City Foundry Co., Michigan City, Ind., of which Albert E. Fort is president. The plant, when completed, will produce malleable castings.

The York Hardware & Brass Co., York, Pa., capitalized at $25,000, will manufacture brass and other castings. J. Elmer, E. D. and R. F. Workman and George S. Macintosh are the incorporators.

Plans are being prepared for the erection of an open-hearth steel foundry for the Machine Steel Casting Co., Alliance, O., which was recently incorporated, with $1,000,000 capital. The concern is affiliated with the Alliance Machine Co. W. H. Purcell is president.

Contracts for the erection of a foundry, 100 x 160 feet and a machine shop, 90 x 260 feet, have been let by the Novo Engine Co., Lansing, Mich. The company at present is building a bank of five core ovens and is installing new equipment in its machine shop.

The Wausau Foundry & Machine Co., Wausau, Wis., has been reorganized, the holdings of the Kratz estate and of Louis and Karl Kratz having been acquired by other stockholders. The capital stock has been increased from $15,000 to $30,000 and extensions to foundry and machine shop facilities are contemplated.

The Delta Foundry & Machine Corp., 545 West Twenty-fifth street, New York, is purchasing the following equipment for its new foundry: One 1-ton gas-fired furnace; five stationary crucible furnaces; two stationary crucible gas-fired furnaces; one stationary core oven; one portable core oven; 12 eighteen-inch round or square flasks; one grinder stand with wheels; one bench grinder; one set of tongs, etc. J. F. Shea is works manager and the new foundry is at 543 West Twenty-fifth street, New York.

The Motor Castings Co., 86 Michigan avenue, Milwaukee, has awarded the following contracts for a gray iron and semisteel casting shop, 111 x 180 feet: General contract, to Riesen Bros. Co., 425 East Water street, Milwaukee; steel sash, Truscon Steel Co.; plumbing and heating, A. Bantelman. The initial installation will be a cupola with a capacity of from 10 to 12 tons a day. Gustave Anderson is general manager.

New Trade Publications

PYROMETRY CHECKING.—Bulletin No. 867-B issued by the Leeds & Northrup Co., Philadelphia, contains a treatise on the importance of standards and of checking in pyrometry. Various equipment of the pyrometer and thermocouple is described and illustrated.

FLEXIBLE SHAFT.—An illustrated 8-page booklet has been published by the Binghamton Flexible Shaft Co., Binghamton, N. Y., in which wire wound flexible shafts and appliances are described and illustrated. Specifications pertaining to various equipment described are given.

LIFT TRUCKS.—The Stuebing Truck Co., Cincinnati, is circulating a cardboard folder, calling attention to a lift truck which it manufactures. According to the folder, with these trucks there is no waste of time in loading and unloading, due to the platforms which are part of the trucking system.

LOCOMOTIVE CRANES.—The Buffalo Hoist and Derrick Co., Buffalo, has issued a 4-page leaflet in which it describes and illustrates its type of locomotive crane. All parts of the crane are of steel castings. The crane is designed for either hoisting operations or for operating a 2-line clam shell grab bucket. The illustrations show the crane in operation.

MOLDING EQUIPMENT.—Modern molding machines are described and illustrated in a 4-page cardboard folder being circulated by the Arcade Mfg. Co., Freeport, Ill. Jolt, roll-over molding machines, pouring devices, spring sprues, core jolters, piston machines and other foundry equipment is described and illustrated.

RAILROAD EQUIPMENT.—Catalog 145 issued by the Whiting Foundry Equipment Co., Harvey, Ill., is devoted to equipment for use in locomotive repair shops. Equipment described includes, screw-jack locomotive hoists; shop trucks; movable jacks for locomotive hoists; spur geared hauling mechanism; transfer tables; cranes and other equipment.

FANS.—The Massachusetts Blower Co., Watertown, Mass., recently published an 8-page condensed bulletin in which all products of the company are briefly described and illustrated. Among the apparatus described are, modified type squirrel cage fans; steel plate fans; propeller fans; mill exhausters; cone fans; heaters; air washers and portable service sets.

WELDING APPARATUS.—The Bastian-Blessing Co., Chicago, is circulating a loose-leaf catalog, in which it describes and illustrates cutting and welding apparatus. Various parts and accessories of this equipment also are described and illustrated.

FAN ENGINEERING.—A booklet devoted to descriptions of fans, blowers and exhausters, recently was published by the Buffalo Forge Co., Buffalo. The equipment described includes blast gates; blowers of all kinds; countershafts; fans, both motor and pulley driven; dust collectors; exhausters and various other equipment. The booklet is fully illustrated and a number of tables are given.

ELECTRIC DRILLS.—Portable electric drills are described and illustrated in a 4-page folder recently published by the Black & Decker Mfg. Co., Baltimore. The motor with which these drills are equipped will operate on either direct or alternating current of 25, 40 or 60 cycles, or on any two wires of a 3-phase circuit. It is cooled by means of a centrifugal fan on the armature shaft. Gears are packed in grease in a grease-tight housing.

ELECTRIC WELDING.—Electric arc welding is treated in a bulletin recently published by the U. S. Light & Heat Corp., Niagara Falls, N. Y. Equipment described includes an arc welder with a stationary direct-current motor-generator; a stationary direct-current converter for a welder; a direct current converter; portable alternating-current motor-generator welder with cover; arc stabilizing reactor; electrode holder; panel for direct current motor-generator; direct-current motor-generator and armature for direct-current motor-generator.

HANDLING EQUIPMENT.—Equipment for handling coal, ashes, sand, etc., is described and illustrated in bulletin No. 202 recently issued by the Lakeside Bridge & Steel Co., North Milwaukee, Wis. According to the booklet one man and this equipment can move coal at the rate of from 30 to 60 tons per hour, depending upon the size of the bucket and the distance the equipment has to travel. In the construction of this equipment, no overhung gears are used in all except motor pinions. Trolley truck bearings are standard with bronze bushings and large oil boxes.

CRANES.—A 50-page illustrated bulletin has been issued by the McMyler-Interstate Co., Cleveland, in which cranes, especially those used in the shipbuilding industry, are described and illustrated. The data which is given is representative of present-day practice and can be used as an index to equipment for ship construction. The cranes described and illustrated in the booklet are: Horizontal cantilever revolving cranes, which include hammerhead, pintle and turntable designs; boom jib cranes, of the pintle and turntable designs; standard locomotive cranes and overhead traveling cranes.

ELECTRIC HOISTS.—Three types of electric hoists are described and illustrated in a 16-page booklet recently published by the Northern Engineering Works, Detroit. The first type described is designed for single hook suspension and may be attached to an overhead crane. The second type is identical with the first described, except that the top hook with its hook saddle is omitted. It is designed for suspension rigidly by bolts through lugs. A third type is similar to the second, but has a longer frame and a longer drum which is grooved to take the wire hoisting rope without overlapping. All three types are fully described and illustrated.

WELDING.—Methods of oxyacetylene welding as applied to the repairing of locomotive fireboxes are described and illustrated in a 40-page booklet recently issued by the Air Reduction Sales Co., New York. The data were devised with the assistance of George L. Walker and R. T. Peabody of the engineering department of the company. The booklet is not a catalog but a treatise on the application of the oxyacetylene process to locomotive shop repairs. Chapters on full welded fireboxes; semi-welded fireboxes; semi-welded half side sheets; full-welded half side sheet; side sheet cracks; patches on firebox sheets; patches on blue sheets, etc., are given. Each chapter is accompanied with a line drawing which is fully analyzed.